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The Benefits of Regulating Hazardous Waste Disposal: Land Values as an Estimator

VOLUME I

by

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Conceptual and empirical examination of whether the social costs imposed by hazardous waste sites are reflected in property values. A hedonic analysis is used, to account for other characteristics of houses that affect their values. After screening many sites, data are collected and analyzed for two of them. For the Andover site, where contamination was detected in on-site wells but not in wells outside the site boundaries, there was no evidence of an effect on property values. For Pleasant Plains, where contaminated wells had to be closed, there was some indication of expected rent gradient. Further analysis is reported in Volume II.

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Preface

This report is submitted by the Public Interest Economics Center (PIE-C) in partial fulfillment of EPA Work Assignment #80. Its purpose is to determine whether differentials in real estate values constitute a valid and useful method of estimating the potential benefits of regulating hazardous waste disposal.

In the performance of this study, the authors have enjoyed the special cooperation and advice of John Harford, of the Economic Analysis Division, and Arthur Koines, Peggy Podalack, and Lawrence Buc of the Office of Solid Waste in EPA.

The project has been very much of a team effort. The basic theoretical work was performed by Robert C. Anderson and Roger C. Dower and is embodied in Chapter II and Appendix A. The entire project was under the direct management of Zena L. Cook who was also responsible for the empirical estimates associated with the Pleasant Plains, New Jersey, site. The empirical estimates associated with Andover, Minnesota, was performed by Margo J. Vickers, who was also responsible for the computer operations. Kenneth J. Adler participated in the field work in Dover and performed much of the work in preparing data for computer processing. Professor Frank P. Brechling of the University of Maryland, as well as Robert C. Anderson and Roger C. Dower, provided technical advice on the econometrics and interpretation of data and results. The project was under the general supervision of Allen R. Ferguson. The manuscript was edited and typed by Bernadette T. Clark, Janet A. Carver, Marilyn E. Matthews and Linda L. Minich, under the management of Vernon W. Palmer, II. In addition Todd Berman has assisted through drafting the diagrams and performing many research assistant functions.

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I. INTRODUCTION

Cost-benefit analysis of environmental regulations and, more generally, the determination of the nature of desirable regulations require the estimation of their potential and actual benefits.

In the regulation of hazardous waste disposal, two generic policy issues have surfaced:

1. Existing disposal sites may pose threats to human health and welfare. What level of remedial action or compensation to the victims is appropriate?
2. New facilities create a disamenity when located in or near an urban area. What types of controls should be used to avoid undesirable risks to health and welfare and what payment is needed to compensate nearby property owners for the disamenities associated with the facility?

These questions involve one common theme: the need to measure the benefits of reduced risk from the disposal of hazardous waste, or, in other words, the damages from exposure to the risks of hazardous waste disposal. The negative value (costs) of a disamenity are typically difficult to measure, because there is no market for most reductions in disamenities. Consequently, indirect methods of measurement must frequently be used.

Economists have identified several distinct conceptual approaches that, in principle, could be used to measure the relevant benefit or damage functions for non-market commodities such as health and environmental risks. One method is to measure current and anticipated physical damages and then place appropriate economic values on these effects. A second is to survey individuals directly concerning the amounts they would pay to reduce risk or the compensation they would demand to bear the risk of proximity to a disamenity. A third approach is to analyze voting behavior when decisions such as hazardous waste siting are subject to a referendum. A fourth method uses prices in related markets to infer the values individuals attach to non-market goods and services.

All these methods have disadvantages as well as advantages. Placing monetary values on risks to health and life defies satisfactory solution; there is no market in which reduced risks are bought and sold. Although medical costs and other resource costs can be used to estimate lower bounds, and a human-capital approach may reflect earning power lost, neither captures the distress and suffering associated with actual illness or premature death. Further, assigning pecuniary values is morally repugnant to some analysts and policymakers. Resorting to even sophisticated questionnaire techniques can not avoid all the problems of the inherently subjective nature of responses to hypothetical questions. As has been shown by Bishop and Haberline,[1] there may be large differences between the amount at which people say they value a thing and the amount they are willing to take for it. The problems with interpreting referenda are both that they are few and that the voters must vote for or against a proposal, not indicate how much they value their support for, or their opposition to, a waste dump.

In this study we are concerned with the last approach--the use of differences in property values--to estimate the value individuals place on the disamenities associated with proximity to a disposal site. Each approach has its own strengths and weaknesses. The property-value approach is particularly attractive for a number of reasons:

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[1] Richard Bishop and Thomas Haberline, "Measuring Values of Extramarket Goods: Are Indirect Measures Biased?," American Journal of Agricultural Economics, (December 1979): 926-30.

- The basic objective of all methods of ascertaining the economic welfare losses associated with a disamenity is to determine willingness to pay for removal of or reduction in the disamenity or, its near equivalent, willingness to be compensated. Property values are objective historical data showing what people were, in fact, willing to pay for property embodying many characteristics, including its associated amenities and disamenities.
- In light of the fact that real property is immobile, differences in property values adjusted for factors other than proximity to a waste site should reflect the cost to property owners of the disamenity.
- The method has been successfully used in evaluating locational disamenities other than dump sites.
- The econometric techniques for isolating the impact of disamenities are available and tested.
- The theoretical basis for the isolation of the price effects of a disamenity and for relating observed price differentials to changes in economic welfare is available, as discussed in Chapter II.
- Although any estimate of welfare loss based solely on property value impacts is only an approximation, it may be possible to identify and to measure, in many instances, major components of over or underestimation.

The property-value method is based on the observation that the value of each piece of residential real estate (lot, developable set of lots, existing house with its lot) depends on the utility derived from housing presently or potentially located on it. The utility of a particular house is a function of a multiplicity of characteristics. If a given characteristic is significant and equally significant to all present and potential owners of houses in a real estate market, a widely perceived change in that characteristic will alter each market participant's evaluation of real estate in the affected area by the same amount.

The simple application of the property-value method implies the following:

1. Proper adjustment has been made for amelioration of effects. Amelioration reduces private loss and is not reflected in the price of real estate in the affected area.[2]

   Should the hazard be ameliorated at public expense, the cost of amelioration should be added to the cost determined from price differentials.

2. In the real estate market in the affected area all participants, owners and prospective buyers, are fully informed of the hazards and other adverse aspects of the waste dump. There is an asymmetry regarding information and its interpretation. If market participants accurately interpret described risks as posing more danger than they objectively do, they may discount the value of affected property more than they objectively "should." However, the perceived risks of individuals constitute a genuine loss in the utility to them of living in the affected area. (To believe

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[2] For ease of exposition, we speak of affected "areas" or "zones." In fact, impacts of the site presumably decline continuously with distance from it, and this is taken into account in the more detailed discussions below.

otherwise would imply that there is no economic cost to malicious rumors that affect property values.) Therefore, a reduction in property values based on such psychological overreaction is appropriately included in computing potential benefits of regulation. In contrast, should market participants underestimate the severity of the hazard and not discount the property as much as they "should," the use of property values would underestimate the social loss, because present or future owners would ultimately discover that the adverse consequences were more than they had anticipated.

3. Similarly, expections are important. In estimating property-value effects for an environmental amenity, it is essential that the transaction be free of expectations of the change. That is, the pre-change sample should be taken before market participants begin to suspect that a change will ensue.
4. All owners and potential buyers have identical tastes and preferences with regard to the disamenity and have identical incomes.

Violation of the first three of these conditions leads to understatement of the costs of the disamenity as estimated by the use of differentials in property values. Hence, if the impacts of heterogeniety are small and if expectations are borne out in the future, estimates of potential benefits of regulation based on this technique should be understated.

The overall purpose of the present study is to determine both in theory and practice whether changes in real property values constitute a valid and useful measure of the costs imposed by a hazardous waste site on the proximate neighborhood and, hence, of the welfare gains potentially achievable through regulating the location or characteristics of such sites.

Subordinate purposes are:

- To examine how, in principle, to isolate and measure changes in property values associated with a hazardous waste site;
- To develop and illustrate the application of a suitable methodology for doing so;
- To measure price effects in specific cases and to learn how EPA might undertake such measurement in making regulatory decisions;
- To explore, through the specific case studies, the conditions under which application of the method would and would not be practical.

The specific hypothesis to be tested empirically is: property values are depressed by the presence of a hazardous waste dump.

The PIE-C approach to accomplishing those purposes is rather straightforward. After a review of the literature and explication of the relevant theory, limitations on and conditions for successful application of the general method are presented (Chapter II and Appendix A).

To isolate the effect of a hazardous waste disposal site on real estate prices, we performed multiple regression analysis using characteristics of individual properties as the determinants of price. Dozens of papers have used some form of such a hedonic analysis to isolate the impact of various factors on property values.[3] Many of these studies have related price impacts to environmental disamenities, especially air pollution, but also proximity to positive amenities. In most cases, the hypothecated relationship between property values and the presence of an amenity or disamenity were found to be consistant with the empirical results.

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[3] Appendix A contains a brief account of the relevant literature.

The method has not been applied previously to evaluate the economic consequences of hazardous waste disposal sites. Hence, this study, in addition to being of value to EPA, should constitute a contribution to the literature of environmental economics.

We developed a cross-section method whose objective is to isolate the effect of the intensity of the disamenities associated with a dump on real estate prices. The period of interest was after the "event"--the institution of a dump or the discovery and publication of the existence of an old facility or of the fact that it was generating some form of hazard. In this approach, distance has been used as a proxy for intensity of exposure.

The alternative of using a time-series analysis of the effect was explored. Two cross-sectional studies, one before and one after the event, were performed for one of the sites. Comparing the price differentials in these cases should provide a check on the accuracy and reliability of the estimate based on an _ex post_ cross-sectional study. Having found land value effects in one site, we compared the gradient as a function of proximity before and after the event.

To test and illustrate the method, two sites (Pleasant Plains, New Jersey, and Andover, Minnesota) were selected for case studies, after examination of a large number of potential locations. In each case, recorded sales prices and recorded housing, neighborhood and socio-economic characteristics were gathered and incorporated into the multiple regression analysis.

Actual property sales are preferred over other indicators of capital values affected by proximity to a disamenity. Assessed values, for example, are only useful to the extent that they reflect actual market prices, and owner estimates of value are subject to several possible errors. Observed sale prices can also be used as proxies for the loss of capital values of residential properties in the area that did not change hands, for the potentially developable residential land in the area and, in some cases, for commercial properties in the area. The total cost of the disamenity was calculated both for residential properties and for all real property in the area examined.

II. PROPERTY VALUES AS A MEASURE OF WELFARE EFFECTS

This chapter presents a simplified discussion of the rationale for using property value differentials as a measure of the welfare effect of a hazardous waste facility. It incorporates parts of Appendix A which provides a more detailed treatment of the underlying economic theory as well as a review of the related literature.

To argue that property values can reflect the economic benefits of varying levels of environmental quality, it is necessary to establish first how environmental quality affects the land market. Land prices for specific parcels should equal the discounted value of the stream of future net benefits attributed to each parcel. Observed market prices reflect transactions among individuals, the transactions resulting from the different values attached to the property by the buyer and the seller. To the extent that environmental quality affects the net benefit stream received from holding a parcel, the value of the parcel to the owner or prospective buyer will rise or fall. For example, an increase in pollution levels in an area, everything else constant, should decrease the net benefits of a residential property, and one would expect that the price for the residence would be lowered.

This relationship can be stated more formally in terms of the utility functions of land market participants. If environmental quality affects the utility derived from purchase or ownership of land, or if environmental quality enters directly in individual utility functions, property values may be affected by environmental change. Either situation is sufficient to ensure that environmental quality appears as a factor in the demand for housing, and, therefore, in the choice of residential location.

If residents and prospective residents indeed do not desire to live near hazardous waste facilities, one would expect that such a facility would have a depressing effect on property values. If a facility is located in or near a residential community, present owners of housing in the affected area may find their property less satisfying than before. Consequently, they may seek to sell it in order to move elsewhere and may be willing to take a lower price than they would have taken before the event.

They may find no buyers at the old, pre-facility, price level, because prospective buyers may also find the facility an unattractive feature of the neighborhood and may correspondingly lower the amounts they would be willing to pay to live there. The consequence is that lower prices would be expected for housing transactions that occur following the siting of a hazardous waste facility in or near an established residential neighborhood. The extent of the price effect should be larger the greater the perceived risk and the more extensive the aesthetic impacts.

Long established waste facilities may also have adverse effects on neighboring property prices. While one would not expect relative prices to be changing as a consequence of proximity to an old facility, unless leaks occurred or other circumstances at the facility change, one might expect to find a stable pattern of depressed prices surrounding the site relative to areas farther away.

A hazardous waste site could affect the value of any property. Residential parcels could be affected through aesthetic and risk dimensions. Commercial property could be affected if a hazardous waste facility influenced the flow of customer traffic or affected the desirability of the location for employees. Farmland might be affected through related changes in agricultural productivity or the demand for farm output. Among these alternative land uses, one would expect the greatest impacts to occur for residential properties. Other uses simply do not have the same magnitude of potential aesthetic loss and adverse health effect. Moreover, as the value of existing housing and other developed property declines in the affected area, the value of property held for future development can be expected to decline similarly.

The potential for making objective observations of any property value effects due to proximity to a hazardous waste site suggests the possibility of using such price effects to estimate the welfare impacts of siting new or existing facilities or upgrading the quality of containment for established facilities. Two steps must be undertaken in order to measure any such welfare effect on residents. First, assuming that housing prices are affected by a site, one must isolate the effect of the facility on housing prices from all other factors that are simultaneously affecting property values. Second, one must translate the price effects attributable to the site into measures of the associated loss of economic welfare. These topics are addressed in turn.

A. Measuring Price Effects

Most recent economic studies of the demand for housing recognize explicitly and formally the common knowledge that housing is a heterogeneous commodity with individual units comprised of bundles of characteristics such as the number of rooms, style, type of construction, location, and neighborhood aesthetics. Hazardous waste facilities and other sources of neighborhood property attributes, thus, enter as elements in the bundle of characteristics that comprise a housing unit. Prices for individual houses reflect the value that buyers and sellers attach to the separate characteristics. Although buyers and sellers may be mentally adjusting the prices they believe a property is worth to them on the basis of characteristics, such adjustments are not recorded. Rather what is observed is a single price for the entire package of characteristics of a given housing unit.

One possible technique for isolating the effect of individual characteristics on price is to make pair-wise comparisons of nearly identical properties. For example, if one could find pairs of properties that were identical in all respects save for their proximity to a hazardous waste facility, one might interpret the average difference in price as the effect of the waste facility. While such an approach may be theoretically valid, it is not feasible. In practice it will not be possible to find properties that are identical in all respects save for distance to a waste site. In particular, properties that are geographically separate, as two must be for one to be near a waste facility and the other to be distant, will be of unequal distance from other neighborhood features that may affect price.

A far superior approach for holding all factors but one constant, while the effects of that single variable are measured, is a multiple regression analysis. Using data on the prices and characteristics of individual properties in a multiple regression analysis, one may isolate the average effect on sale price for each characteristic. Such a regression of sale prices on house characteristics is termed a "hedonic" equation. The coefficient of a variable such as "distance from a hazardous waste facility" would then represent the amount, on average, that prices were affected by this variable.

In this context, distance from the site would be, as mentioned in the Introduction, a proxy for the intensity of exposure to the risks from contamination and the aesthetic impact of the site. However, pure linear distance may be a poor indicator of the combined effects of aesthetics and perceived risk. Risk, itself, may be a complex function that reflects several potential pathways for contaminants to reach humans. The potential complexity of risk and aesthetic measures suggest that one may want to consider several specifications other than simply linear distance for any hazardous waste facility variable in a hedonic equation. In addition, other locational amenities and disamenities can be expected to affect price. As distance from the waste site varies, so do distances from these other space-specific amenities. Consequently, problems of collinearity are likely to emerge in the empirical analysis.

B. Measuring Welfare Effects

Assuming that the hedonic analysis described above does find a price effect from a nearby waste site, there remains the issue of interpreting such an effect in terms of welfare economics. As a preliminary caution, it should be noted that this subject is complex and the reader is referred to Appendix A for further details.

First, it is possible to interpret the regression results directly in terms of the hedonic approach that guided the development of the regression analysis. At the risk of oversimplification, the basic line of reasoning in doing so is that the coefficients of the hedonic equation are interpreted as the marginal willingness of consumers to pay to acquire more of the individual characteristics. Then, to measure benefits, or changes in welfare from an action such as removing an offending waste site from a neighborhood, one simply multiplies the indicated marginal willingness to pay times the average base price of property (the waste facility is removed entirely) and sums this effect over all affected houses or all affected units of property. Theoretically, one could measure the benefits of partial amelioration (less than removal of the site) by treating degrees of amelioration as being equivalent to some increase in distance from the actual polluting site.

Converting observed marginal willingness to pay into an estimate of benefits in this way produces accurate results only if a number of specific conditions are fulfilled. The marginal willingness to pay must be constant over the relevant range of values of the intensity of the disamenity (distance from the dump, in this case). If the marginal value differs from the value of large discrete changes in the quanitity of a characteristic, an error is introduced. Also, as mentioned in the Introduction, inadequate information or its misinterpretation by market participants can lead to property values that are poor measures of the actual impacts.

Third, it is necessary that all households be identical in tastes and income. Thus, they should all have identical demand curves for the separate characteristics of housing.

Clearly, not all of these assumptions are met in practice. Households are not identical in tastes and income; some are more risk averse and some have greater distaste for aesthetic insults. Although it would be desirable to take account of these differences among individuals, there are no examples in the literature of successful attempts to do so. Consequently, we too find it necessary to use the standard assumptions.[4] In addition, the measured marginal willingness to pay may not be constant for large changes in the characteristics. The challenge facing researchers is to select samples and to adjust the regression equations so that the actual welfare loss is closely approximated in the analysis.

C. An Alternative Analysis of Welfare Effects

A second and somewhat simpler analysis is available for converting any observed price differential attributable to disintensity of a disamenity to impacts on welfare. It derives from a more conventional application of comparative statics to the demand for and supply of real property. Whereas, there is some merit in considering both prospective buyers and present owners of real property as having a demand for that property and combining their offering prices and reservation demand prices into a single demand function, the principles are more readily explained by separating buyers from sellers. For purposes of exposition we begin with the market for housing only.

In the Figure we draw the *ex ante* demand curve of prospective buyers as D_0 and the reservation demand curve of present owners as S_0. The curves represent offering and asking prices for housing with a standard mix of characteristics or, alternatively, an average of prices for the actual mix of characteristics. In reality both curves would be rather broad bands, like many market demand and supply curves. The demand curve requires no further comment. The supply curve slopes upward on the presumption that more owners would be willing to sell at high than at low prices. The curve becomes vertical where quantity equals the existing number of units, $\overline{Q}$, sold. (The possibility of building more houses does not greatly affect the analysis, as is mentioned below). In the status quo ante the equilibrium number of units sold per time period is Q_0 at price P_0.

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[4] At present, one of the authors intuits that it is possible to demonstrate that the impacts of heterogeneity of tastes can be expected to be relatively small in most practical situations. However, we have been unable to develop a proof of that proposition at this point.

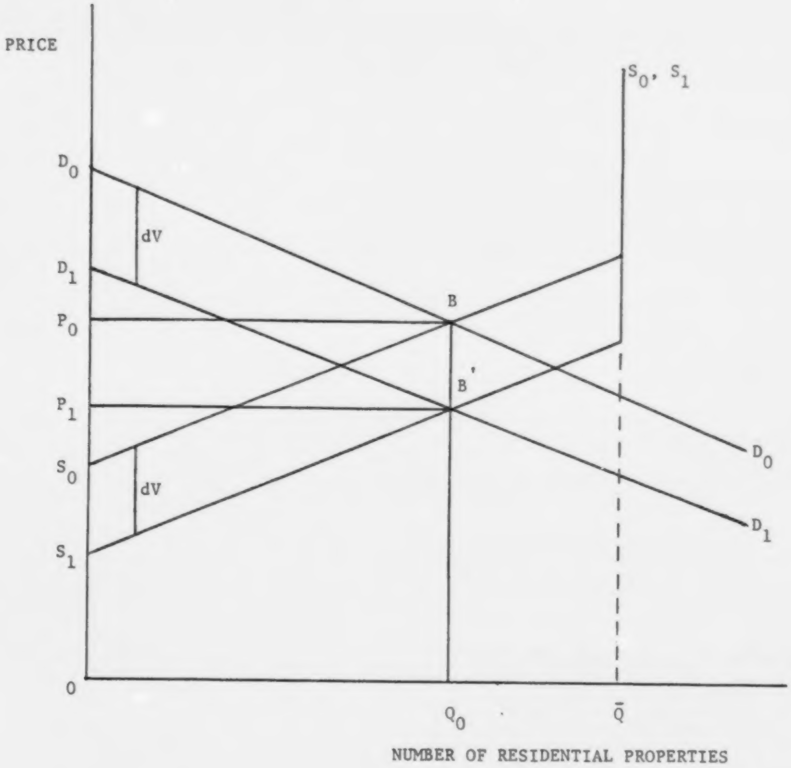
If a disamenity is injected into the market, most, if not all, market participants will reduce the value they place on the property. (If that were not the case, the "disamenity" would not be a disamenity.) Buyers will reduce their offering price because the new discounted value of the stream of satisfactions (utility) they would gain from living in the area is reduced.

Owners will, similarly, face the prospect of reduced utility and will redcue the price at which they could be induced to sell. Assuming all buyers and sellers evaluate the disamenity equally (have homogeneous tastes in this respect) the demand and supply curves fall by equal increments, dV in Figure 1. With linear demand curves, there is demonstrably no loss in consumers surplus; $AP_0 = AP_1$ and Q is unchanged. That this is the case is obvious from the fact that the new demand price is equal to the old one reduced by an amount dV that would leave buyers exactly as well off by purchasing the property at the new price with the disamenity as they would have been by purchasing it at the old offering price without the disamenity.

All the social cost of the disamenity is borne by present owners, and it is borne by all present owners in the affected area, those who

FIGURE 1

Disamenties and Property Values


PRICE
S_0, S_1
D_0
dV
D_1
B
P_0
B'
P_1
S_0
dV
D_0
D_1
S_1
0
Q_0
$\bar{Q}$
NUMBER OF RESIDENTIAL PROPERTIES

do not sell as well as those who do. This is true because those who sell accept a lower price than would have been necessary before the dump influenced values, and those who do not sell face lower satisfaction from ownership. In both cases, the present value is reduced by the capitalized (negative) value of the disamenity. No significance attaches, incidently, to an analysis of producers' surplus, as that is usually represented diagramatically. The reason for this is that the downward shift in the supply function does not represent a reduction in input of resources but is a one-time capital loss (like that of any other inventory loss).

With dV constant and equal on both sides of the market, output remains constant and $dV = dP$, the change in price. Consequently, the observed price change, as calculated in the regression analysis, represents the welfare loss per unit of real property, and $dV\overline{Q}_0$ provides an estimate of the potential benefit of total amelioration.

In order to take account of undeveloped land and the potential for increasing the supply of housing in the affected area, S_0 and S_1 can be considered the horizontal sums of the asking prices of both lots with and without houses. Similarly, the demand curves represent the demand for developed and undeveloped lots. The demand and supply prices of lots without houses are specified to include the cost of adding a newly constructed house of standard or average characteristics.

This interpretation is dependent upon the same assumptions pertaining to homogeneity of tastes, incomes, and to information and expectations as explained in Section B, above.

III. THE SITE SELECTION PROCESS

In the previous section, we presented the conditions necessary for using property value differentials to estimate accurately the welfare losses associated with new or existing hazardous waste sites. These considerations influenced the choice of sites used to measure the effects. In this section we describe briefly our site selection process, including the criteria used to identify and choose sites.

One of the considerations in deriving welfare loss estimates is that tastes and income are assumed identical for all households. To this end, we have chosen sites with populations that are relatively homogeneous with respect to income, race and education.

Further, we selected sites which had large residential populations located in close proximity to a hazardous waste site. Relatively large populations were expected to produce sufficient turnover of residential property to produce a useable data base on transactions. Moreover, only residential properties were selected for the purposes of establishing welfare losses. This was expected to minimize the effect of industrial or commercial ventures which might actually gain from the presence of a hazardous waste facility. The difference between the real estate desires of residential versus commercial or industrial activities can be thought of as presenting extreme differences in preferences. For example, it is possible that proximity to a hazardous waste facility have positive value to some firms.

We attempted to find sites with no other major sources of disamenities in order to facilitate the isolation of the effects of the hazardous waste facilities.

Other criteria for site selection are discussed in Appendix B, but are briefly mentioned here. Information is the most important of these for the generation of price reliable effects. Since land value changes depend on the perceptions of market participants, they should have some knowledge of the existence of the disamenity and some perception of its possible risks.

To some extent, different sites offer opportunities to measure different types of effects. For example, we could use actual contamination of the air or water from a site as an indicator of effect. Alternatively, we could use the physical siting of a facility in a neighborhood. Finally, we could examine the effects of potential contamination.

Using the site selection criteria described above[5], we eventually selected, from a universe of approximately 150 potential sites, four sites for data collection. Of these, sufficient observations were available at three, but sufficient usable observations were available at only two. The two sites ultimately selected were in Pleasant Plains, New Jersey, and in Andover, Minnesota, a suburb of Minneapolis.[6] The justification for the selection of these sites is presented in Appendix B.

A. Site A

Pleasant Plains is a small community located approximately 3 miles north of Toms River, in Dover Township, Ocean County, and approximately 5 miles west of the Atlantic Coastline. It had a population of 5,600 persons in 1980.

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[5] A thorough description of the site selection process is presented in Appendix B.

[6] Full descriptions of both sites are presented in Appendix B.

An illegal dumping operation occurred between March and December, 1971,[7] on a former chicken farm in Pleasant Plains. Contamination of the groundwater in the upper of two aquifers in the area occurred as a result of the dumping operation. A physical description of the area in which the dumping operation took place and the site of the dumping are presented in Map 1.

The Pleasant Plains site was chosen for the purpose of this study for several reasons:

- the availability and number of transactions both before and after the episode;
- the magnitude of information on housing characteristics;
- the relatively homogeneous nature of the local housing market;
- public knowledge of the incident within that housing market of Pleasant Plains and its environs--the town of Toms River;
- the recent residential growth in the area, specifically the development of land in the period after contamination was first discovered (Pleasant Plains has been the recent main area of growth of the Toms River region);
- the relative homogeneity of the population (Pleasant Plains may be characterized as having been in the 1970's a desirable white, middle-income community with one-acre lots interspersed with a few farms)[8] and;

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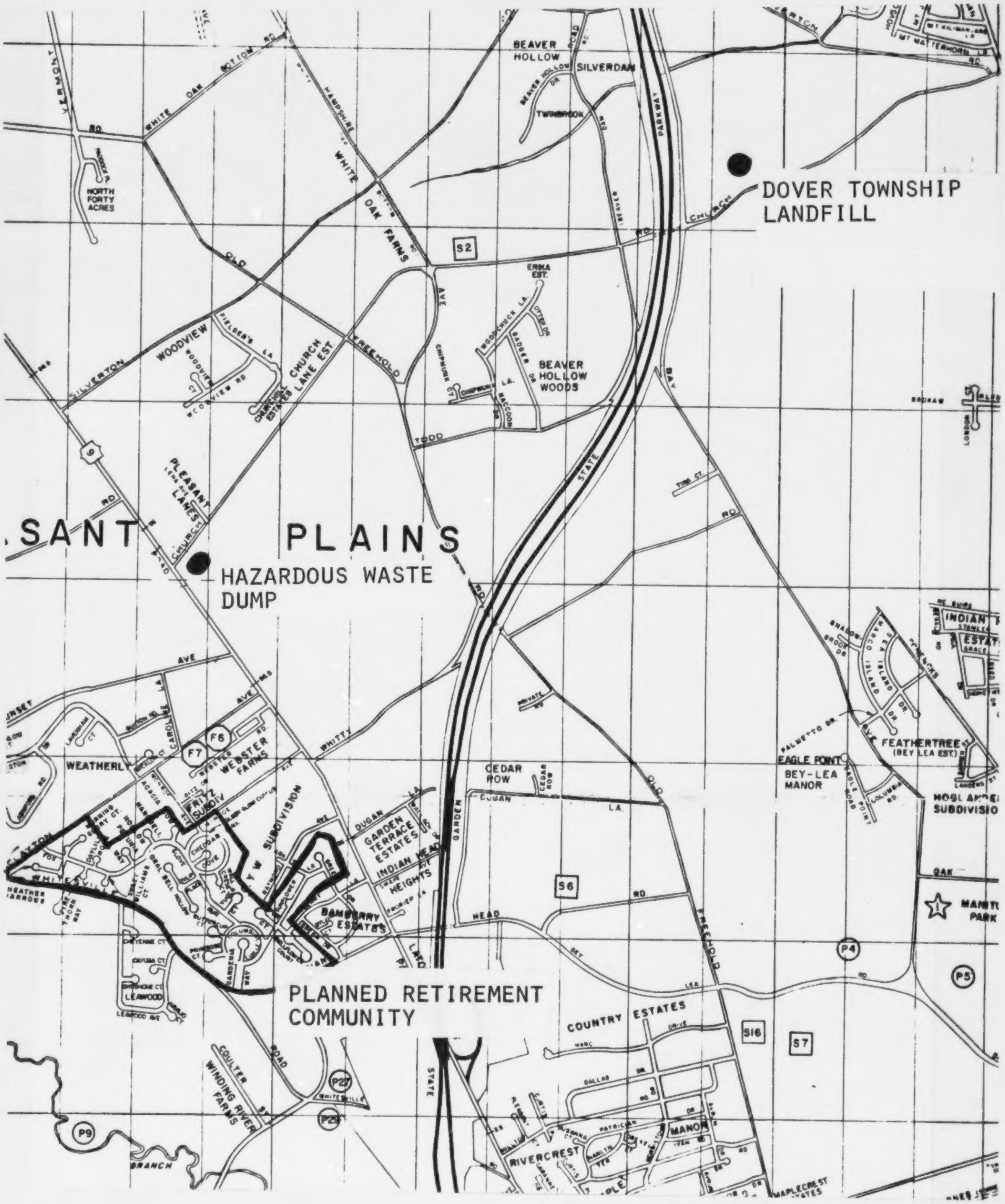
[7] The wastes dumped included aromatic hydrocarbons, benzene, toluene, styrene, xylene, ketones, alcohols and phenolic resins.

[8] It may be argued that the senior citizens' residential community, located inside Pleasant Plains, is a separate housing market. The model was developed to account for any differences.

Map 1

Pleasant Plains


DOVER TOWNSHIP LANDFILL
SANT PLAINS
HAZARDOUS WASTE DUMP
PLANNED RETIREMENT COMMUNITY
BEAVER HOLLOW
SILVERDAM
NORTH FORTY ACRES
WHITE OAK FARMS
S2
BEAVER HOLLOW WOODS
PLEASANT LANES
WEATHERLY
WEBSTER FARMS
F6
F7
CEDAR ROW
GARDEN TERRACE ESTATES
INDIAN HEAD HEIGHTS
BAMBERRY ESTATES
EAGLE POINT
BEY-LEA MANOR
FEATHERTREE (BEY LEA EST.)
S6
S16
S7
P4
P5
P9
P27
COUNTRY ESTATES
RIVERCREST
MANOR
LEAWOOD
WINDING RIVER FARMS
GARDEN STATE PARKWAY

- the essentially residential nature of the area, (there is little industry and most businesses are involved with services for the residents of the area).

One would not necessarily expect the price effects from the Pleasant Plains incident to be large. Local and state officials intervened swiftly after the first discovery of contamination. They mitigated some of the threat of further contamination and took responsibility for some of the costs associated with the incident.[9] Clean up of the site was initiated soon after contamination was first discovered and within a month a municipal water supply was installed and connected to part of the affected area. Residents within a mile of the zone were ordered to close their wells, and those within a zone approximately a 1 to 1 1/2 mile radius from the contaminated site were ordered to extend their wells into the deeper (uncontaminated) aquifer. Some of the costs initially borne by private well users were reimbursed.

Nevertheless, resistance to these measures by residents was significant, particularly in regard to the capping of their wells. It was charged that the municipal water was not of equivalent quality to the contaminated well water, either in terms of taste or in terms of safety. In addition, those residents who were forced to dig into the deeper aquifer complained that its taste and smell was much worse than water from the shallow wells. Hence, besides the quantifiable effect on private wells resulting from the contamination incident, there is the inherently unquantifiable perception of increased health risk to local residents.

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[9] Another possibly mitigating factor against a strong price effect is the fact that no contamination had been discovered in Pleasant Plains since 1976.

It should, however, be pointed out that living near a waste site or over a contaminated aquifer may or may not be exposing residents and their progeny to health risks.

Based on these feelings of the residents, there is some reason to expect a property value effect reflecting the loss of use of the preferred private wells and the proximity to a risk of unknown magnitude. Present residents could be expected to value their homes somewhat less because of the deterioration in water quality and possible insecurity about future risks from the site. Consequently, they would presumably be prepared to accept a somewhat lower price for their homes after the discovery of the contamination incident, compared with before. Similarly, everything else being equal, new buyers could have been expected to offer a lower price for a given property. Also, because many of the purchasers of homes in the Pleasant Plains area are from Toms River, they would have been aware of the problems generated by the contamination episode, the quality of the municipal water and, therefore, the meaning of the loss of the use of the upper aquifer. (They used municipal water in Toms River.)

B. Site B

Andover, is a relatively small city situated approximately 20 miles north of Minneapolis, in Anoka County. It is bounded by the cities of Ramsey and Anoka on the west, Coon Rapids on the south, Ham Lake to the west and Oak Grove to the north (see Map 2). The entire area of study has a fairly homogeneous white population with an estimated per capita income in 1977 of $5,658.[10] Andover, in 1981, had a population of 9,520.[11]

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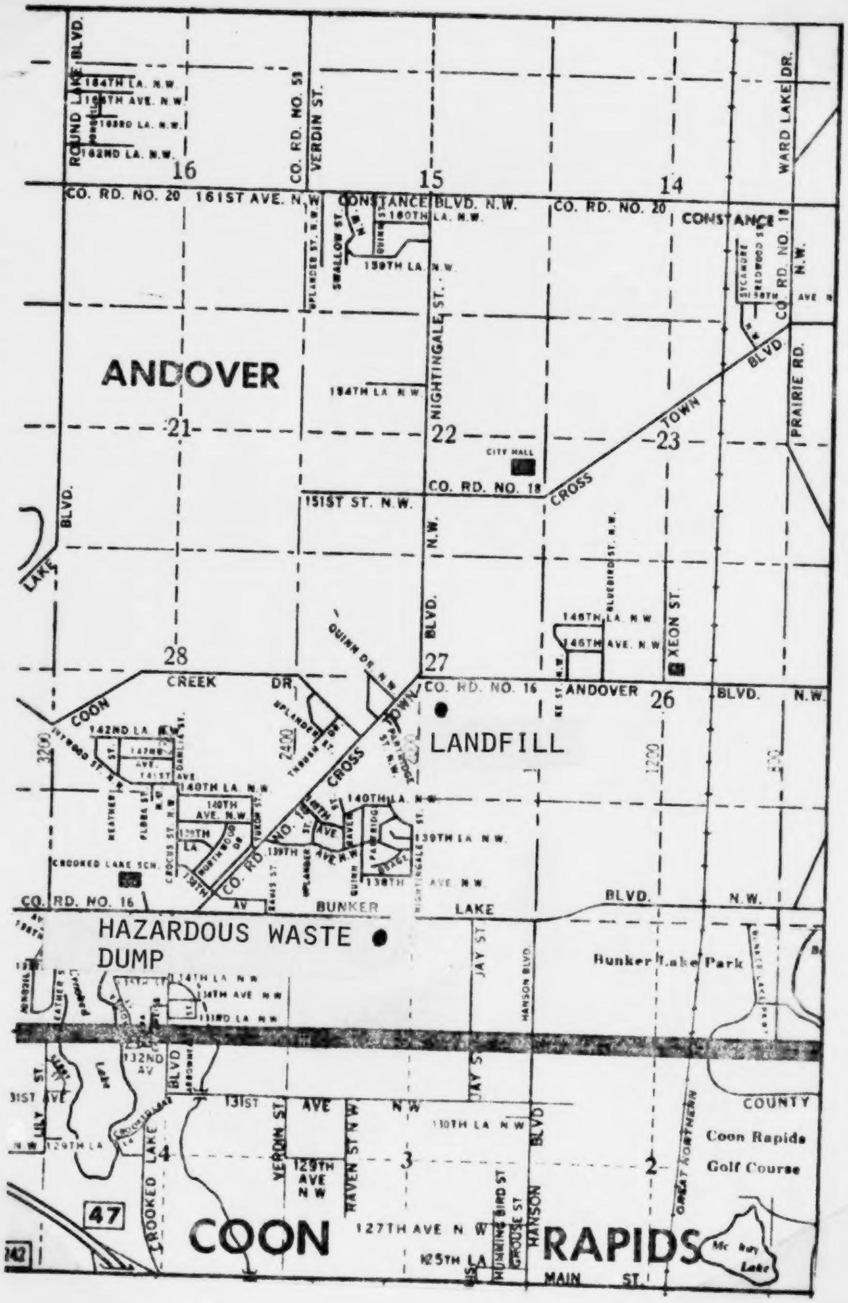
[10] Bureau of Census, 1977 per Capita Money Income Estimates for Counties, Incorported Places, and Selected Minor Civil Divisions in Minnesota.

[11] Metropolitan Council of the Twin Cities Area; figures for 1981.

Map 2

Andover


ANDOVER
LANDFILL
HAZARDOUS WASTE DUMP
COON RAPIDS
16
15
14
21
22
23
28
27
26
4
3
2
ROUND LAKE BLVD.
164TH LA. N.W.
163RD LA. N.W.
162ND LA. N.W.
CO. RD. NO. 58
VERDIN ST.
CO. RD. NO. 20
161ST AVE. N.W.
CONSTANCE BLVD. N.W.
160TH LA. N.W.
159TH LA. N.W.
CONSTANCE
WARD LAKE DR.
CO. RD. NO. 18
N.W.
154TH LA. N.W.
NIGHTINGALE ST.
CITY HALL
CO. RD. NO. 18
151ST ST. N.W.
CROSS TOWN BLVD
PRAIRIE RD.
LAKE BLVD.
BLVD.
146TH LA. N.W.
146TH AVE. N.W.
XEON ST.
BLUEBIRD ST. N.W.
COON CREEK DR.
QUINN DR. N.W.
CO. RD. NO. 16
ANDOVER BLVD. N.W.
142ND LA. N.W.
140TH LA. N.W.
140TH AVE. N.W.
CROSS TOWN
CO. RD. NO. 16
140TH LA. N.W.
139TH LA. N.W.
138TH AVE. N.W.
CROOKED LAKE SCH.
CO. RD. NO. 16
BUNKER LAKE BLVD. N.W.
JAY ST
HANSON BLVD.
Bunker Lake Park
134TH LA. N.W.
134TH AVE. N.W.
133RD LA. N.W.
132ND AV
131ST AVE
131ST AVE N.W.
130TH LA. N.W.
129TH LA.
129TH AVE N.W.
CROOKED LAKE BLVD
VERDIN ST.
RAVEN ST. N.W.
127TH AVE N.W.
125TH LA.
HUMMINGBIRD ST
GROUSE ST
HANSON BLVD
MAIN ST.
GREAT NORTHERN
COUNTY
Coon Rapids Golf Course
Mc Kay Lake
47
242
3200
2400
1200

The waste site[12] (owned by a Cecil Heidelberger) is located at 2052 N.W. Bunker Lake Boulevard, in the southern part of Andover (Map 2).[13] A second site of interest was also discovered in Andover. This is a municipal landfill located 1/2 mile north of the hazardous waste site next to Coon Creek where, many years ago, hazardous waste was buried in an asphalt-lined pit, the lining of which has now begun to deteriorate.

The Andover site fulfills the site selection criteria for the most part. There is a continuous, fairly homogeneous suburban population around the site, and there is some evidence of public knowledge of the contamination incident. Unlike Pleasant Plains, however, the Andover site was chosen because it is an example of a site for which there was more of a threat of further contamination than actual contamination at the time of the study. Only 3 wells had been found to be contaminated and all were located on the Heidelberger property. Also, the nature of this threat was not known at the time the observed sales took place. It was thought likely that a property value effect might result from the potentially substantial costs involved in introducing a municipal water system in this area, if this proved to be necessary. The expected incidence of the costs would likely influence property values if they were expected to fall on the individual property owners. However, since contamination is largely a threat rather than an actuality, and owners have not yet had to face the possibility of paying for a correction to the municipal water supply, property value effects may be expected to be relatively small.

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[12] The site received many barrels of waste solvents, paints, inks, glues, and grease since 1973, and many of the barrels had deteriorated and had begun to leak before they were removed.

[13] The southerly location of the dump and the fact that the northern part of Andover is sparsely populated necessitated the inclusion of another juridiction. The two cities for which data were collected, therefore, were Andover and Coon Rapids (population 36,660 in 1981).

IV. THE METHODOLOGY FOR ESTIMATING PRICE EFFECTS AND TESTING THE HYPOTHESIS

This section sets forth the method by which the price effects generated by a hazardous waste site were measured empirically. Testable hypotheses are developed for the two chosen sites.

The methodology used in this study has been developed and described in some detail in Chapter II and Appendix A, where it is pointed out that distance to a dump site or the existence of contaminated private wells may provide a reliable proxy for measuring the effects produced by a hazardous waste site. The methodology used to test these hypotheses formally is a cross-section regression of the sales price for individual properties on the charateristics of the properties including housing and neighborhood characteristics, environmental parameters not related to the site, and other locational attributes.

Two cross-section studies of property values, one before and one after the siting of a facility or the discovery of contamination, should be superior to a single cross-section equation. Under this approach the pre-site/pre-contamination price gradient (change in price with distance) may be compared with a post-site/post-contamination gradient to show impacts at various distances from the site. Differences between the gradients may be reasonably imputed to the siting of the waste facility or to the discovery of contamination, as the case may be. A price gradient produced by a single cross-section analysis after the event, on the other hand, may be more difficult to interpret. (There may be factors unaccounted for by the model which may produce or obscure a gradient.)

It is realized that linear distance alone may not be sufficient to describe the important relationships. The association between the source of contamination and impacts on property value need not be linear. Also, contamination does not move at the same speed in all directions. This means that points equidistant from the contamination source are not expected to generate the same price effects. Thus, ideally the direction of underground movement of water in the aquifer should also be considered where there is water pollution. The direction of the wind should likewise be considered where there is air pollution.

The Pleasant Plains and Andover sites provide an opportunity to test the effect of waste sites on surrounding property values. In general terms, the basic hypothesis for both sites is that the known existence of the hazardous waste site and the known effects generated by them had a depressing effect on property values. In both cases the dump existed but was relatively unknown before the contamiantion incident. Thus, it is difficult to separate the effects generated by the contamination episode from the disamenity effects of a well publicized dump site. The widespread evidence of contamination in Pleasant Plains, nevertheless, suggests a more specific hypothesis in this case. Since contamination was the principal disamenity and there were no expected negative aesthetic effects, it is presumed that contamination was the principal problem in Pleasant Plains.

The differences between the two sites also potentially provide further insight into the behavioral responses to the incident and the ultimate price effect. For example, the Andover site mainly represents a threat to private well contamination, while the Pleasant Plains site had actual widespread contamination of private wells. Thus, it is possible to test indirectly the notion that people respond more to actual contamination than to the threat of it.

The Pleasant Plains site also potentially offers an opportunity to ascertain whether contamination of private wells in an area offers a better measure for the disamenity effects than distance from the known source of contamination.

The existence of contamination was reported in a New Jersey EPA report in which official zones of contamination were defined.[14] In scrutinizing the evidence on contamination in Pleasant Plains, it became apparent that the identified zones were not entirely reliable. There had been evidence during the months following the first discovery of contamination that some wells outside the specified zones were contaminated, that monitoring results varied from day to day inside the zone and that some wells inside the zone were not known to be contaminated.

In view of the controversy surrounding the interpretation of the monitoring results, it was not possible to test the proposition that people responded to contamination of their individual wells per se. Rather, only the hypothesis that people responded to the officially designated zone of contamination was tested.

For the Pleasant Plains site, analysis is based on two distinct models, each applied to two different samples. Model I represents the waste site as discrete distance measurements; whereas in Model II the designated contamination zone is used as a proxy for the dump. Delineation of the samples was simply on the basis of pre-1974 and post-1974 sales. In contrast, Andover is represented by one sample and a single model.

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[14] U.S. Environmental Protection Agency, Office of Solid Waste Management Programs, Final Report - Analysis of a Land Disposal Damage Incident Involving Hazardous Waste Materials, Dover Township, New Jersey, by M. Ghassemi, (Redondo Beach, CA: TRW Systems Group, May 1976).

Denoting the general form of the vector of housing and lot characteristics by X, the locational characteristics by Y and the variables denoting date of sale by T, the price model is specified in general terms as follows:

$$\text{Model 1} \quad LPV = a + bX + cY + dT + eD + u$$

where D is the variable or set of variables representing distance from the dump and LPV is the sales price of each house, specified in log form. Some house characteristics, such as house size and lot size, were also specified in log form for the two sites.

The data from both sites for the period after contamination was discovered were applied in a cross-section analysis of housing prices in an area of approximately a 2 1/2 mile radius from the waste sites using the model described above. The variable D, representing distance from the dump, was used as a proxy for the intensity of contamination. It was hypothesized that house prices, ceteris paribus, would increase with distance from the source of contamination, but that at some distance they would approach the equilibrium value of houses that are located far from the site. The relationship between distance and prices, therefore, was not expected to be linear. The data are consistent with the hypothesis; the test of this hypothesis is that the price gradient is statistically significant in the Pleasant Plains case.

In order to test the hypothesis that the gradient before the incident was different from that after it, the Pleasant Plains data were divided into pre- and post- 1974 sales. It was considered possible, using this

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[15] The first contaminated well was discovered approximately 2 years after the illegal dumping operation had commenced. This event, which precipitated public awareness of the illegal dumping, would also be measured by the method described above.

approach, to isolate the effect of the contamination episode itself.[15] A price gradient measured prior to contamination was expected to provide information on the effects potentially generated by any other disamenities in the area prior to the contamination episode. Comparison with a post-contamination price gradient should demonstrate that what is actually being measured is the effect of contamination on price.[16] The effects on price of being within the identified zones of contamination (Zone I and Zone II)[17] were also tested in a second model (Model II). Instead of distance dummy variables, indicators were used for whether the property was in the contaminated zone:

$$\text{Model II} \quad LPV = a + bX + cY + dT + eZ + u$$

where Z represents the contaminated zone.

Data on all of the recorded housing sales for both sites were obtained from the respective county assessment offices, for the period from the third quarter in 1968 to the last quarter in 1981 for Pleasant Plains, and from the second quarter of 1978 to the last quarter of 1981 for Andover. For each sale, data were obtained from the assessment cards on characteristics of the home and lot. Sample sizes were 250 in Andover and 675 for the combined Pleasant Plains samples. The date of transfer of the deed was entered by quarter as an individual independent variable.

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[16] Two assumptions need to be made in order to interpret the results of such a study, i.e., that there are no significant changes in tastes during this period and that residents were not affected by the presence of any co-located negative externalties before, compared with after the contamination experience.

[17] Two contamination zones were identified. Zone I represents the area in which wells were ordered to be capped and the municipal water supply introduced. Zone II represents the area in which deeper wells were ordered to be dug. Not all wells were found to be contaminated in Zone II.

The time variable is expected to capture the effect of general price level changes as well as any other factors that change over time such as interest rates.[18] A set of site specific variables was also included to reflect the location of individual properties relative to other disamenties and amenities in each area. Detailed socio-economic information for individual neighborhoods was not available. However, population density (person per room) and housing density (houses per acre) were available as a proxy for neighborhood socio-economic status.

Non-linear and linear specifications of the variables showing distance from the waste site were tested in both Pleasant Plains samples. In addition, in order to observe how property values change with changes in distance from the site , a set of distance dummy variables was constructed to present the information in very general terms.

The distance dummy variables and distance specified as a simple linear term were expected to have positive signs. The non-linear quadratric squared term (D^2) and the reciprocal term $\frac{1}{D}$ were expected to have negative signs. In the latter case property values were expected to rise steeply at first then asymptotically approach the equilibrium price level away from the site.

In a quadratic specification the distance effect could be either "U" shaped or "inverted U" shaped, neither of which is supported by our prior reasoning. The contamination variable in the second model using zones was expected to have a negative sign. This is because the contaminated area is expected to be negatively correlated with property values.

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[18] An alternative way of specifying price level changes was with a linear trend. However, it was not considered reasonable to assume that these changes would be necessarily linear.

The expected signs of the coefficients associated with housing characteristics are positive except, in some cases, where they are dummy variables. For the latter case, in the Pleasant Plains samples, a zero value is given where there is a feature such as a basement or fireplace, and a value of 1 given where there is not. The coefficients are, therefore, expected to be negative. The reverse is true for Andover. The sales date dummy variables are expected to have positive coefficients, because of general inflation over the period.

The expected signs for individual neighborhood variables are discussed along with the results in the next section.

V. RESULTS

The regression results are presented in Tables 1 and 2 for the Pleasant Plains samples and in Table 3 for the Andover sample.

The final equations presented and discussed below are the results of extensive careful empirical analyses and statistical tests. The steps undertaken to produce the preferred descriptive model and to test the hypotheses of this study are described primarily in Appendix C. In total, 27 equations are presented for the Pleasant Plains samples and 11 for the Andover sample.

A. Pleasant Plains

Table 1 presents the results of the pre-1974 sample and the post-1974 sample run separately both using Model 1 (where distance is used as a proxy for the effects of the dump). Table 2 presents the results of the combined sample using Model 2 (where contamination zones are used as a proxy for the effects of the dump). The equations underlying these tables are in semi-log form; consequently, the coefficients shown in the table can be interpreted as showing the percentage change in price associated with each. Equation 1, sample 1, seems to provide the best results for Model 1 both in terms of goodness of fit (R^2) and in terms of statistical significance for the individual variables (F Statistic), including the variables representing distance from the waste site.

In equation 1, sample 1, distance from the waste site was specified as eleven 1/4 mile dummy variables.[19] A gradient plotted with the coefficients of the individual quarter mile dummy variables is presented in Figure 2. This gradient indicates in general terms that property values

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[19] Each dummy represents the observations inside eleven concentric circles--each 1/4 mile apart.

Table 1

Pleasant Plains Regression Results for Sample 1 and Sample 2

Dependent Variable Natural Log of Property Values	Regression Coefficient (Standard Error)	
	Equation 1, Sample 1 Post-1974 Data	Equation 1, Sample 2 Pre-1974 Data
Variables[1]		
Constant	1.599595	2.408774
Neighborhood Variables		
Natural Log of Distance from Central Business District (In Miles)	.0776899* (.03328)	-.0291194 (.06349)
Distance from the Garden State Parkway (In Miles)	.1053314* (.03978)	.0028489 (.10052)
Distance from the Access to the Parkway (In Miles)	-.0604575 (.05155)	.0145000 (.01665)
Distance to the High School[2]	-.1984953* (.08165)	-.6455401* (.23675)
Distance to the Hazardous Waste Source (In Miles)	See Figure 2	See Figure 3
Average No. of Rooms Per Person According to Enumeration District	.1119172* (.05452)	.0432376 (.10398)

*An indication of the coefficients which are statistically significant at the 95% level.

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[1] A full description of the variables is given in Appendix C.

[2] This variable was trended so that all residences within 1/4 mile were given the value .25, within 1/2 mile .5 and outside 1/2 mile 1.

Table 1 (continued)

Pleasant Plains Regression Results for Sample 1 and Sample 2

Dependent Variable Natural Log of Property Values	Regression Coefficient (Standard Error) Equation 1, Sample 1 Post-1974 Data	Equation 1, Sample 2 Pre-1974 Data
Variables		
House Characteristics		
Age	-.0013026 (.00068)	.00102944 (.00157)
Natural Log of House Area (in sq. feet)	.2977651* (.03635)	.1931030* (.07401)
Basement (1 if no basement)	-.0449415* (.01378)	.0332259 (.03648)
Air conditioning (1 if no air conditioning)	-.0485741* (.01251)	-.0889687* (.02898)
Fireplace (1 if no fireplace)	-.0549834* (.01455)	-.0639212 (.04498)
Bathroom Fixtures	.0521778* (.01524)	.1331987* (.04538)
Garage (A) if no garage	**	**
Garage (B) (1 if 1 garage)	.0689773* (.026321)	.1659923* (.06327)
Garage (C) (1 if 2 garages)	.0816214* (.02746)	.2102363* (.07120)
Garage (D) (1 if 3 or more garages)	.0535160 (.06474)	.3786271* (.13270)

*An indication of the coefficients which are statistically significant at the 95% level.

**Ommitted dummy.

Table 1 (continued)

Pleasant Plains Regression Results for Sample 1 and Sample 2

Dependent Variable Natural Log of Property Values	Regression Coefficient (Standard Error)	
	Equation 1, Sample 1 Post-1974 Data	Equation 1, Sample 2 Pre-1974 Data
Variables		
Class of House (Class 4)[3]	-.3982160* (.07293)	-.6588789* (.24716)
Class of House (Class 3)	-.2803524* (.05378)	-.3739844 (.17397)
Class of House (Class 2)	-.0509555 (.04964)	-.1462648 (.15968)
Class of House (Class 1)	**	**
Condition of the House (1 = good, 2 = fair 3 = poor)	-.1797863* (.03219)	-.1801360 (.10958)
Lot Characteristics		
Natural Log of Lot Size (In Thousands of Feet)	.05682508* (.01636)	-.0335453 (.04888)
Number of Outbuildings	.0497313* (.02064)	.0814083 (.06956)
Zone A (Rural Residential) Minimum Lot 43,560 sq ft	.1270313* .06086	No Observation
Zone B (Rural Highway Business/Residential/Commercial) Minimum Lot 43,560 sq ft	.0530327* (.05504)	.3673595* (.14731)
Zone E (R-150 Residential Zone; not Cluster)	-.02207217 (.02240)	.01815032 (.05227)

*An indication of the coefficients which are statistically significant at the 95% level.

**Ommitted dummy.

---

[3] See Appendix C for a full description of this variable.

Table 1 (continued)

Pleasant Plains Regression Results for Sample 1 and Sample 2

Dependent Variable Natural Log of Property Values	Regression Coefficient (Standard Error)	
	Equation 1, Sample 1 Post-1974 Data	Equation 1, Sample 2 Pre-1974 Data
Variables		
Zone F (Planned Retirement Community) Minimum Lot 5,000 sq ft	-.0805636* (.02867)	-.1019895 (.7984)
Zone J (R-400 Residential Zone) Minimum Lot 45,500 sq ft	.0464310 (.05140)	-.4765513* (.14975)
Zone M (R-120 Residential) Minimum Lot 12,000 sq ft	**	**
Pool (In ground)	.2120923* (.08571)	.0983940 (.11340)
Pool (Vinyl)	.1371651* (.02658)	.0327478 (.05681)
Time Variables		
Sales Date 1/4 Year Dummy Variables Trended[4]	.9914428* (.03646)	1.014053* (.07341)
R^2	.90087	.82655
$\bar{R}^2$	.89216	.78811
F	103.40832	21.50507
SE	.11219	.14167

*An indication of the coefficients which are statistically significant at the 95% level.

**Ommitted dummy.

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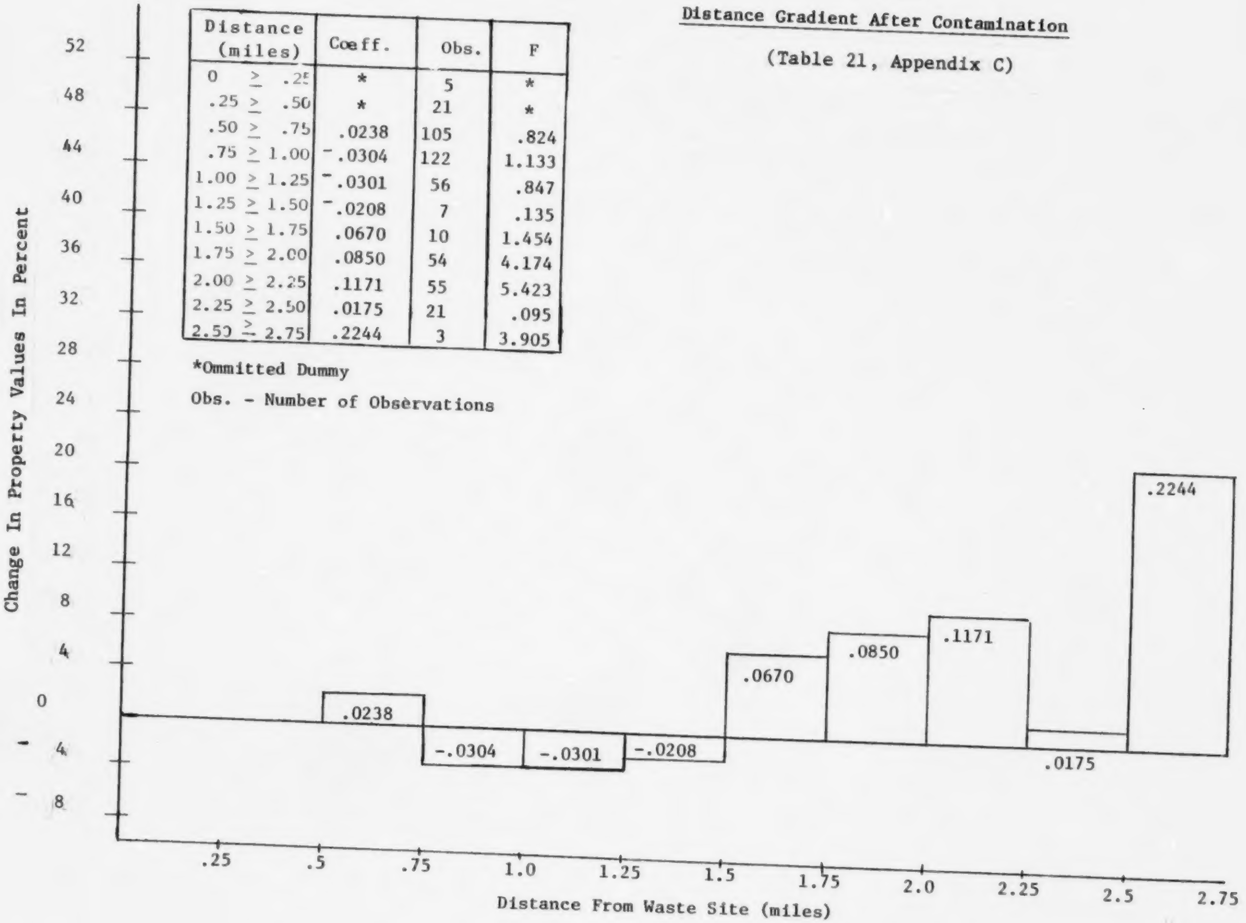
[4] The individual 1/4 year coefficients of the dummies ran separately were multiplied by their respective dummy values and added so that they took the form of a single continuous variable. This was largely done for the purpose of exposition and did not affect the other coefficients in the equation or the $\bar{R}^2$.

Figure 2

Distance Gradient After Contamination

(Table 21, Appendix C)



Distance (miles)	Coeff.	Obs.	F
0 ≥ .25	*	5	*
.25 ≥ .50	*	21	*
.50 ≥ .75	.0238	105	.824
.75 ≥ 1.00	-.0304	122	1.133
1.00 ≥ 1.25	-.0301	56	.847
1.25 ≥ 1.50	-.0208	7	.135
1.50 ≥ 1.75	.0670	10	1.454
1.75 ≥ 2.00	.0850	54	4.174
2.00 ≥ 2.25	.1171	55	5.423
2.25 ≥ 2.50	.0175	21	.095
2.50 ≥ 2.75	.2244	3	3.905

*Ommitted Dummy

Obs. - Number of Observations

are depressed in the vicinity of the waste site. Residences 1.5 to 1.75 miles from the site sell on average for 6% more than those which are within .5 miles of the site. Also houses that are 2.5 to 2.75 miles away from the site sell on average for 22% more than those that are within a mile.

The results for equation 1, sample 1, also indicate, as expected, positive effects of house size, lot size and assorted living extras such as basements, fireplaces, garages, etc. The time related variables were also highly significant, indicating, as expected, inflationary as well as real price effects in the housing market from year to year. Further, some of the neighborhood variables were also significant and with the predicted signs.

Of neighborhood variables, distance from the Garden State Parkway was significant and with the predicted (positive) sign. This coefficient was expected to capture the nuisance effect of being close to a busy highway. Distance from the access to the parkway, though not significant at the 95% level, also had the predicted sign. The coefficient representing distance from the central business district, Toms River, was positive rather than negative, as is usually hypothesized in the literature. The latter result demonstrates that property values rise in and around Pleasant Plains the further one goes from the central business district, Toms River. This may be due to the fact that for the majority of the observations (located in the south and southwest quadrants of Pleasant Plains) being further from the central business district also means being closer to Pleasant Plains. Anecdotal evidence suggests that

Pleasant Plains is regarded as a better place to live than is downtown Toms River.

While the elementary school did not appear to have any significant effect on house prices,[20] distance from the high school was strongly negatively correlated with house prices. Property values one mile away from the high school were 20% lower than property values nearby. This result suggests that the amenity is important to residents.

Table 1 also describes the results for the sales that occured before the 1974 contamination episode (sample 2) that were tested using the same model (Model 1). Overall, similar results were generated in both samples for the variables describing housing characteristics. However, the neighborhood variables, in particular, were generally insignificant in sample 2 and, furthermore, tended to have unpredicted signs.[21]

There is some evidence that the area underwent some changes during the period of study (from 1968 to 1981). In particular, it became fashionable to live in Pleasant Plains, rather than in downtown Toms River in the early to mid 1970s. This may explain why Distance from the Central Business District (DCBD) has the predicted (negative) sign for the "before" sample, and an unpredicted positive sign for the "after" sample.[22]

In accordance with the hypothesis, the waste site dummy variables for the pre-1974 sample are statistically insignificant. This means that the price gradient for this sample is not, in statistical terms, significantly different from zero (See Figure 3). Further, it can be observed from Figure 3 that the coefficients do not suggest any consistent pattern. This means that house prices do not appear to be affected by distance from the waste site. While the problem of multicollinearity evident in sample 2 suggests that these results may not be entirely reliable,[23] the above provides support for the proposition that, in the absence of contamination, the specific location which later produced the disamenity had no depressing impact on house prices.

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[20] This was established in earlier runs, not reported in the tables.

[21] Other exceptions were lot size, which had the wrong sign, and fireplace and basement, which were insignificant. Some zone variables also had different signs in sample 2. Also, the model fit sample 1 better than sample 2.

[22] This result has to be interpreted cautiously. There appeared to be a problem of multicollinearity among the neighborhood variables, particularly in sample 2. It is possible that this could account for the different sign.

The results for the pre-1974 sample (Sample 2) may be contrasted with those for the post-1974 sample (Sample 1) briefly described earlier. For sample 1, a positive and statistically significant gradient that rises fairly consistently after 1.5 miles from the waste site was observed. Further, from 1.75 to 2.25 miles and after 2.5 miles, the coefficients on the dummy variables are statistically significant at the 95% confidence level. The results generated by the "after" sample (Sample 1), therefore, also support our prior hypothesis.

The gradient observed for sample 1 also suggests some specific features of interest. First, the distance at which the coefficients are positive and statistically different from zero corresponds to the periphery of the contaminated zone in the southern and eastern quadrants of Pleasant Plains. This suggests that the distance variable is picking up some of the contamination effect.[24] It may also be noted that property values are

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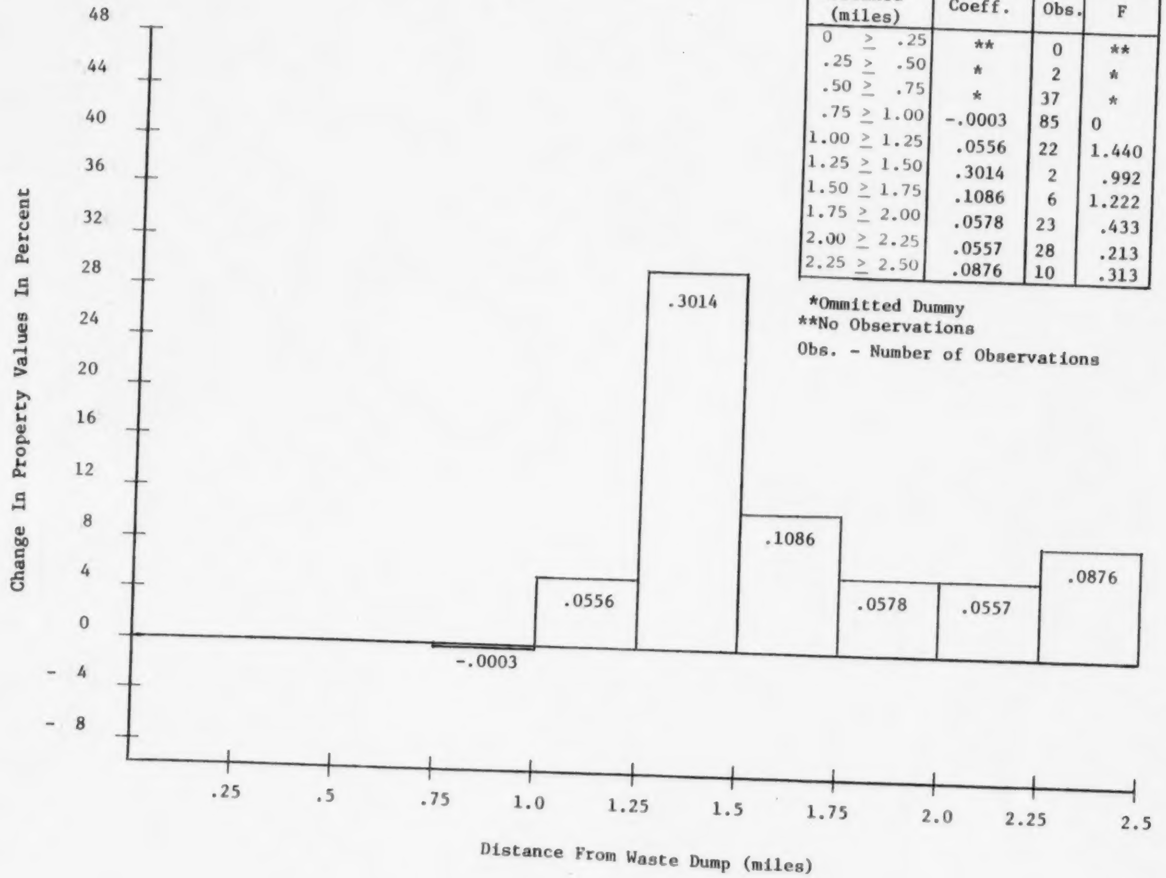
[23] See footnote 22.

[24] This is particularly likely because the southern periphery appears, from the available evidence, to be a more reliable border of contamination.

Figure 3

Distance Gradient Before Contamination

(Table 26, Appendix C)



Distance (miles)	Coeff.	Obs.	F
0 ≥ .25	**	0	**
.25 ≥ .50	*	2	*
.50 ≥ .75	*	37	*
.75 ≥ 1.00	-.0003	85	0
1.00 ≥ 1.25	.0556	22	1.440
1.25 ≥ 1.50	.3014	2	.992
1.50 ≥ 1.75	.1086	6	1.222
1.75 ≥ 2.00	.0578	23	.433
2.00 ≥ 2.25	.0557	28	.213
2.25 ≥ 2.50	.0876	10	.313

*Ommitted Dummy
**No Observations
Obs. - Number of Observations

relatively higher around the 1 to 1 1/2 mile mark for sample 2 than for sample 1. This suggests that the dump may have had a dampening effect on house values after 1974 at this distance.

Several other specifications were used to test the property value effects of the waste dump with respect to distance. A detailed description of these are presented in Appendix C. Briefly, the reciprocal transformation with and without a linear term was found to be insignificant. The double log version of the distance variable was also statistically insignificant and with the "wrong" sign.

The two demarcated contamination zones[25] were tested in various ways to determine whether they were useful for identifying the effects of contamination. One of these tests was with a combined pre-1974 and post-1974 sample, the result of which is presented in Table 2. The results of this and other tests demonstrated fairly conclusively that the contamination zones designated by the New Jersey Environmental Protection Agency may not be reliable indicators of the contamination problem. As evidenced by the coefficients for the variables, "contamination I" and "contamination II," properties situated inside the contamination zones seem to be higher in value (than those outside), rather than lower. This result does not correspond to the prior hypothesis but may be attributed to the unreliability of the contamination zone designations.

Moreover, there is reason to believe that the contaminated zone variable can not be independently specified. This is because the boundary of Pleasant Plains corresponds to the outer boundary of contamination

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[25] Zone 1 corresponds to the area in which the households were ordered to seal their wells. Zones II corresponds to the area in which the households were ordered to dig deeper wells.

Table 2

Pleasant Plains Regression Results for Combined Sample Using Contaminated Zones

Dependent Variable Natural Log of Property Values	Regression Coefficient (Standard Error)
Variables	
Constant	
Neighborhood Variables	
Log of Distance from Central Business District (In Miles)	-.02878951 (.02106)
Distance from the Garden State Parkway (In Miles)	.0343608 (.03800)
Distance from the Access to the Parkway (In Miles)	.0491057 (.02999)
Distance to the High School[1]	-.2115232* (.08399)
Contamination Zone I (If Inside Zone--after Jan. 1974)	.0652184 (.03773)
Contamination Zone II (If Inside Zone--before Jan. 1974)	.0286988 (.02207)
Average Rooms per Person According to Enumeration District	.0280148 (.04687)

*An indication of the coefficients which are statistically significant at the 95% level.

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[1] This variable was trended so that all residences within a quarter of a mile were given the value .25, within a half mile .5 and outside a half mile 1.

Table 2 (continued)

Pleasant Plains Regression Results for Combined Sample Using Contamination Zones

Dependent Variable Natural Log of Property Values	Regression Coefficient (Standard Error)
Variables	
House Characteristics	
Age	.0014726* (.00067)
Natural Log of House Area (in sq. feet)	.3089936* (.03561)
Basement (1, if no basement)	-.0291957 (.01465)
Air conditioning (1, if no air conditioning)	-.0465765* (.01310)
Fireplace (1, if no fireplace)	-.0545352* (.01598)
Bathroom Fixtures	.0662329* (.01625)
Garage A (1, if no garage)	**
Garage (1, if 1 garage)	.0605540* (.02731)
Garage Number (1, if 2 garages)	.0878687* (.02880)
Garage Number (1, if 3 or more garages)	.0933383 (.06465)
Class of House (Class 4)	-.4652950* (.08066)
Class of House (Class 3)	-.2965931* (.05947)

*An indication of the coefficients which are statistically significant at the 95% level.

**Ommitted dummy.

Table 2 (continued)

Pleasant Plains Regression Results for Combined Sample Using Contamination Zones

Dependent Variable Natural Log of Property Values	Regression Coefficient (Standard Error)
Variables	
Class of House (Class 2)	-.1023078 (.05548)
Class of House (Class 1)	**
Condition of the House (1 = good, 2 = fair, 3 = poor)	-.1835900* (.03392)
Lot Characteristics	
Natural Log of Lot Size (In Thousands of Feet)	.0697358* (.01687)
Number of Outbuildings	.0481351* (.02106)
Zone A (Rural Residential) Minimum Lot 43,560 sq ft	-.0112230 (.05195)
Zone B (Rural Highway Business/Residential/Commercial) Minimum Lot 43,560 sq ft	.04116878 (.05734)
Zone E R-150 (Residential Zone; not Cluster)	-.0014164 (.02621)
Zone F (Planned Retirement Community) Minimum Lot 5,000 sq ft	-.0339311 (.03560)
Zone J (R-400 Residential Zone) Minimum Lot 45,500 sq ft	-.0599618 (.05394)
Zone M (R-120 Residential) Minimum Lot 12,000 sq ft	**

*An indication of the coefficients which are statistically significant at the 95% level.

**Ommitted dummy.

Table 2 (continued)

Pleasant Plains Regression Results for Combined Sample Using Contamination Zones

Dependent Variable Natural Log of Property Values	Regression Coefficient (Standard Error)
Variables	
Pool (In ground)	.0870860 (.07047)
Pool (Vinyl)	.0880807* (.02736)
Time Variables**	
R^2	.92155
$\bar{R}^2$	.91068
F	84.80691
SE	.13263

*An indication of the coefficients which are statistically significant at the 95% level.

**See Appendix C for the results of the full list of sales variables.

zone II, and there is evidence that Pleasant Plains is more highly valued for unrelated reasons than the area outside. Therefore, a negative effect on prices, brought about by contamination, may have been offset by the positive value of living in Pleasant Plains. This latter effect cannot easily be controlled by the model.

B. Andover

The results for the Andover sample are presented in Table 3. In contrast to the Pleasant Plains results for the equivalent sample (after the discovery of contamination), the dump variable when expressed as a single linear term was insignificant and had an unpredicted sign. In addition, distance from the other waste site in the area, the landfill, carried the correct sign, but was insignificant. Property values were expected to be positively correlated with distance from the waste dump. However, the negative sign of its coefficient indicates that the existence of contamination had triggered no decline in property values

Despite the failure to show significant results as a function of distance from the waste site, the Andover model appears to be well designed, because it produces appropriate findings on other variables. As shown in Table 3, the results for the Andover sample were similiar to those of Pleasant Plains, with regard to housing characteristics such as ground-floor area[26] fireplace and housing styles. Ground floor area, which carried the expected sign as well as being very significant, indicates that an increase of 1% in ground floor area generates approximately a 0.5 %

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[26] The log of GFA was used in order to capture suspected decreasing returns to scale associated with the variable. However, this specification did not visibly improve its explanatory power.

Table 3

Andover Regression Results

Dependent Variable Natural Log of Property Values	Regression Coefficient (Standard Error)
Variables[1]	
Constant	.7694669
Neighborhood Variables	
Distance from Bunker Hill Outside 1.5 miles	-.1014969* (.04512)
(Recreation Site)	
Distance from Crooked Lake Elementary (In Miles)	.0140567 (.04820)
Distance from Washington Elementary (In Miles)	-.0605006 (.09894)
Distance from Wilson Elementary (In Miles)	-.0600659 (.04404)
Distance from Roosevelt Junior High (In Miles)	.1193512* (.05514)
Distance from Main Highway into Minneapolis (In Miles)	-.0155210 (.02952)
Distance from Central Business District (In Miles)	-.0105190 (.02164)
Distance from the Waste Site (In Miles)	-.0505798 (.04462)
Distance from the Landfill (In Miles)	.0414750 (.04427)
Lake View (In Miles)	-.1020730* (.04164)

[1] See Appendix C for a full description of the variables.

*Coefficients that are significant at the 95% level.

Table 3 (continued)

Andover Regression Results

Dependent Variable Natural Log of Property Values	Regression Coefficient (Standard Error)
Variables	
House Characteristics	
Age	-.00668238* (.00132)
Natural Log of Ground Floor Area (sq ft)	.5003685* (.06560)
Number of Bedrooms	.0384741* (.01162)
One and One Quarter Stories (Housing Style)	-.2993583* (.08669)
One and One Half Stories (Housing Style)	-.3947195 * (.16048)
Rambler (Housing Style)	-.3150149* (.05374)
Split Entry (Housing Style)	-.2735871* (.05380)
Split Level (Housing Style)	-.2640650* (.06143)
Two Stories (Housing Style)	**
Fireplace (1 if yes)	.0453648* (.02019)
Lot Characteristic	
Lot Size (in thousands of feet)	.0009444 (.00053)

*Coefficients that are significant at the 95% level.

**Ommitted dummy

Table 3 (continued)

Andover Regression Results

Dependent Variable Natural Log of Property Values	Regression Coefficient (Standard Error)
Variables	
Time Variables	
Sale Date Dummy Trend[1]	.9608067* (.11568)
R^2	.68967
$\bar{R}^2$	.65604
F	20.50652
SE	.11622

*Coefficients that are significant at the 95% level.

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[1] Individual 1/4 year dummies were trended to produce a single value, as in the Pleasant Plains sample.

increase in property values. Two-story homes[27] appear to be the most valuable type of housing, priced at approximately 40% more than the next preferred one and one-half story structure. As expected, residents place a high value on proximity to the lake and are, therefore, willing to pay a premium of 10% in order to have a view of the lake. The coefficient associated with a garage has the predicted sign but was unexpectedly insignificant. Especially in light of the subzero temperatures often experienced in Minnesota, this is suprising. In addition, lot size was insignificant.[28]

The sale date trend[29] was the most significant variable and also had the expected sign. Neighborhood characteristics were statistically insignificant,[30] except distance from Roosevelt Junior High School. This variable along with distance from Washington Elementary School carried unpredicted signs. Further, the central business district as well as all the other variables carried the predicted signs.

The fact that the results do not indicate that the dump and landfill are environmental disamenities is contrary to prior hypotheses and demands further explanation. Early analysis of the two disamenity variables demonstrated that there was a problem of multicollinearity between them. This is borne out by a correlation coefficient of .84184 for the equation described in Table 3. The correlation matrix also indicated high collinearity among the neighborhood variables as well as between the neighborhood variables and the waste dump and landfill.

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[27] The ommitted dummy.

[28] Lot sizes (LSZ) that exceeded 2.5 acres were deleted from the sample to reduce the effect of potential subdivision and future development. As a result, the sample size was reduced by 21 observations. The variation in LSZ was reduced, probably causing the variable to be insignificant. It had been significant in previous runs when the larger lots were left in.

[29] The sale date variable was trended in the same way as in the Pleasant Plains model.

[30] The presence of the waste dump variable in the equation is the likely explanation for the relative insignificance of the neighborhood variables. These variables have all co-existed at high levels of significance in prior specifications. (See Appendix C, Table 30.)

Several efforts were made to isolate the effect of the waste site on land values. For example, two separate models were formulated to distinguish the effects of the waste site and the landfill from neighborhood amenities and/or disamenities. All neighborhood variables were included in the first model (Model A), but all were ommitted from the second (Model B). Each of these models was tested with different combinations of the waste site variables. The first equation in each model included the dump; the second the landfill; and the third, both (see Tables 31-33 and 34-36 in Appendix C).

Comparison of the results from the two models did not suggest that the model had been originally misspecified. In general, the results confirm the absence of significant property value changes for the dump and landfill. Distance from the waste dump and distance from the landfill were insignificant both with and without neighborhood factors. The neighborhood variables are, on the other hand, significant when the landfill and dump are ommitted from the equation (see Table 30, Appendix C). This suggests that other neighborhood factors were more important to property owners and prospective purchasers than were the dump and the landfill.

It may be noted that neither distance from the waste dump nor distance from the landfill were specified as a single continuous variable in either of the above mentioned models. Instead, the variables were disaggregated into 1/4 mile dummy variables in order to establish whether a price gradient exists. As Figure 4 indicates, the general tendency (when neighborhood factors are ignored) is for property values to decline as one moves away from the dump. The decline, however, is not systematic and no equilibrium seems to be approached over the distance observed. For the same model, there was no strong tendency for property values to change as one moved away from the landfill (Figure 5).

As illustrated by Figures 6 and 7, whenever the distance from the waste dump and distance from the landfill dummies are combined in the same equation, some of the dummies associated with each disamenity become significant. However, the significant waste dump dummies are generally beyond the 1.5 mile point, which implies that for the first 1.5 miles away from the dump, changes in property values are not significantly different from zero.

Moreover, when the dump and landfill are entered together, each exhibits a pattern vastly different from that observed when they are entered independently. The general tendency is for property values associated with the dump to decline as distance from the site increases. In contrast, values tend to increase as one moves away from the landfill.

This strange outcome can be attributed to multicollinearity since the proximity of the dump and landfill make it very difficult to separate their individual effects. Indeed, after approximately the first 1/2 mile, the further a property is from the landfill, the further it is from the dump in many parts of the area.

DISTANCE COEFFICIENT FROM
TABLES 34-36 & 33 IN APPENDIX C

FOR FIGURE 4

Distance (miles)	DWD Coeff.	DWD F	Obs.
0 ≥ .25	*	*	4
.25 ≥ .50	-.0521	.485	14
.50 ≥ .75	-.0461	.389	17
.75 ≥ 1.00	-.0542	.568	31
1.00 ≥ 1.25	-.0047	.004	25
1.25 ≥ 1.50	-.0172	.059	28
1.50 ≥ 1.75	-.0760	.790	6
1.75 ≥ 2.00	-.1075	2.150	25
2.00 ≥ 2.25	-.0853	1.353	22
2.25 ≥ 2.50	.0135	.029	12
2.50 ≥ 2.75	-.0497	.379	12
2.75 ≥ 3.00	-.0999	1.780	20
3.00 ≥ 3.25	-.0424	.319	25
3.25 ≥ 3.50	-.0466	.227	5
3.50 ≥ 3.75	**	**	0
3.75 ≥ 4.00	-.2838	3.571	1

FOR FIGURE 5

Distance (miles)	DLF Coeff.	DLF F	Obs.
0 ≥ .25	*	*	3
.25 ≥ .50	-.0615	.692	8
.50 ≥ .75	.0118	.032	15
.75 ≥ 1.00	.0011	0	9
1.00 ≥ 1.25	-.0084	.015	12
1.25 ≥ 1.50	.0654	.866	10
1.50 ≥ 1.75	.0616	.839	13
1.75 ≥ 2.00	-.0434	.465	17
2.00 ≥ 2.25	-.0287	.205	17
2.25 ≥ 2.50	.0517	.600	10
2.50 ≥ 2.75	-.0026	0	1
2.75 ≥ 3.00	**	**	0
3.00 ≥ 3.25	.0011	0	4
3.25 ≥ 3.50	.0298	.089	5
3.50 ≥ 3.75	-.0777	.557	4
3.75 ≥ 4.00	-.0128	.019	7
4.00 ≥ 4.25	.0188	.044	13
4.25 ≥ 4.50	-.0176	.029	18

FOR FIGURE 6

Distance (miles)	DWD Coeff.	DWD F	Obs.	DLF Coeff.	DLF F	Obs.
0 ≥ .25	*	*	4	*	*	3
.25 ≥ .50	-.0639	.710	14	-.0378	.270	8
.50 ≥ .75	-.0755	1.043	17	.0454	.408	15
.75 ≥ 1.00	-.0525	.484	31	.0262	.126	9
1.00 ≥ 1.25	-.0011	.000	25	.0076	.013	12
1.25 ≥ 1.50	-.0980	1.551	28	.1719	5.113	10
1.50 ≥ 1.75	-.1612	2.746	6	.0929	1.934	13
1.75 ≥ 2.00	-.1944	5.314	25	.0692	1.008	17
2.00 ≥ 2.25	-.1554	3.392	22	.0962	1.705	17
2.25 ≥ 2.50	-.0792	.664	12	.1725	5.327	10
2.50 ≥ 2.75	-.0955	1.027	12	.1390	.779	1
2.75 ≥ 3.00	-.1769	4.006	20	**	**	0
3.00 ≥ 3.25	-.1674	3.341	25	.2590	4.336	4
3.25 ≥ 3.50	-.1050	.355	5	.2717	4.173	5
3.50 ≥ 3.75	**	**	0	.1268	1.034	4
3.75 ≥ 4.00	-.5253	7.928	1	.2507	4.851	7
4.00 ≥ 4.25	N.A.	N.A.	N.A.	.2779	5.713	13
4.25 ≥ 4.50	N.A.	N.A.	N.A.	.2038	1.352	18

FOR FIGURE 7

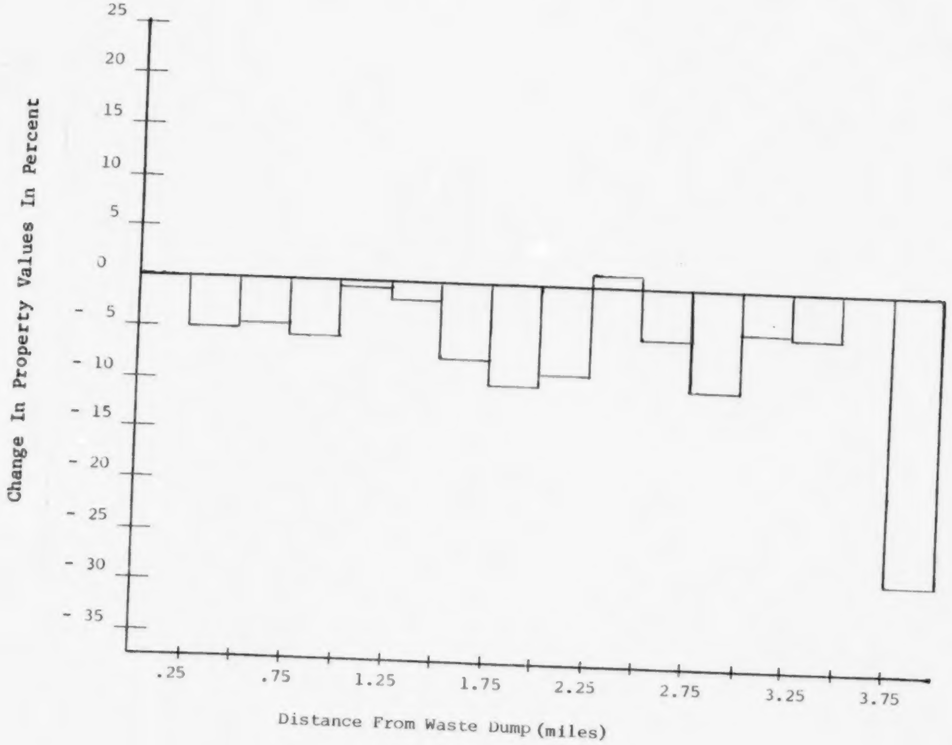
Distance (miles)	DWD Coeff.	DWD F	Obs.	DLF Coeff.	DLF F	Obs.
0 ≥ .25	*	*	4	*	*	3
.25 ≥ .50	-.0473	.366	14	-.0917	1.486	8
.50 ≥ .75	-.0455	.342	17	-.0063	.007	15
.75 ≥ 1.00	-.0703	.764	31	-.0265	.099	9
1.00 ≥ 1.25	-.0420	.217	25	.0122	.019	12
1.25 ≥ 1.50	-.1667	3.027	28	.1516	2.087	10
1.50 ≥ 1.75	-.2810	4.695	6	.1282	1.291	13
1.75 ≥ 2.00	-.2831	4.078	25	.1812	2.227	17
2.00 ≥ 2.25	-.2643	2.912	22	.2214	2.860	17
2.25 ≥ 2.50	-.1870	1.141	12	.2861	4.023	10
2.50 ≥ 2.75	-.3306	2.469	12	.3877	2.426	1
2.75 ≥ 3.00	-.4222	3.747	20	**	**	0
3.00 ≥ 3.25	-.4490	3.773	25	.2665	.693	4
3.25 ≥ 3.50	-.4289	2.656	5	.2503	.555	5
3.50 ≥ 3.75	**	**	0	.2130	.347	4
3.75 ≥ 4.00	-.4989	1.217	1	.3687	1.056	7
4.00 ≥ 4.25	N.A.	N.A.	N.A.	.4784	1.533	13
4.25 ≥ 4.50	N.A.	N.A.	N.A.	.4423	1.155	18

*Ommitted Dummy
**No Observations
Obs. - Number of Observations
N.A. - Not Applicable

Figure 4

Model B:* Distance From the Waste Dump
Without Neighborhood Amenities

(Table 34, Appendix C)

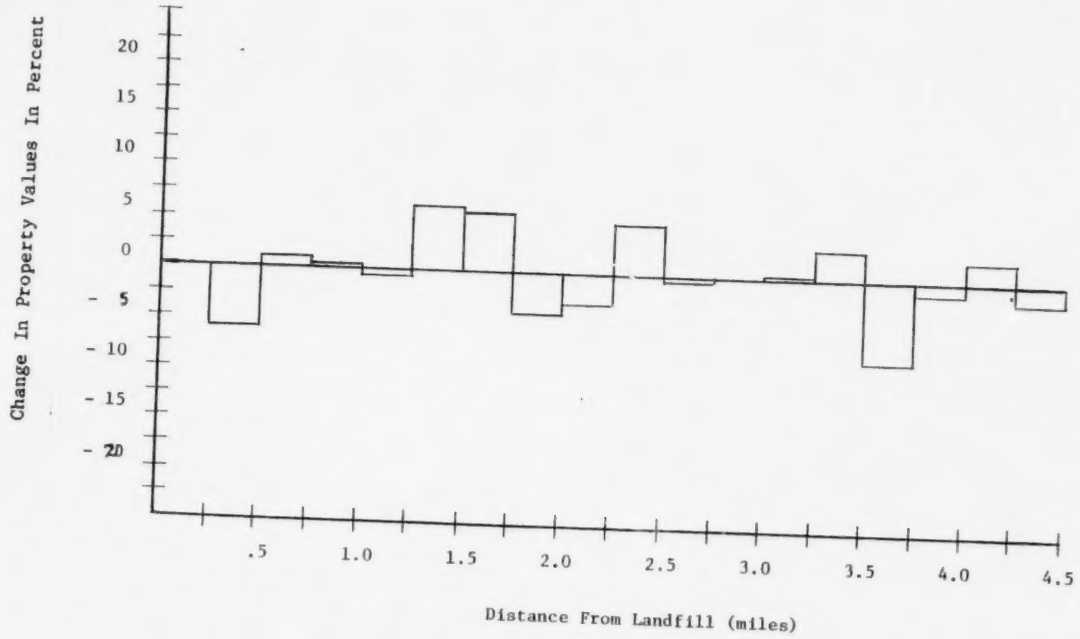


*Model B meets the Specification of Model I described earlier.

Figure 5

Model B:* Distance From the Landfill Without Neighborhood Amenities

(Table 35, Appendix C)

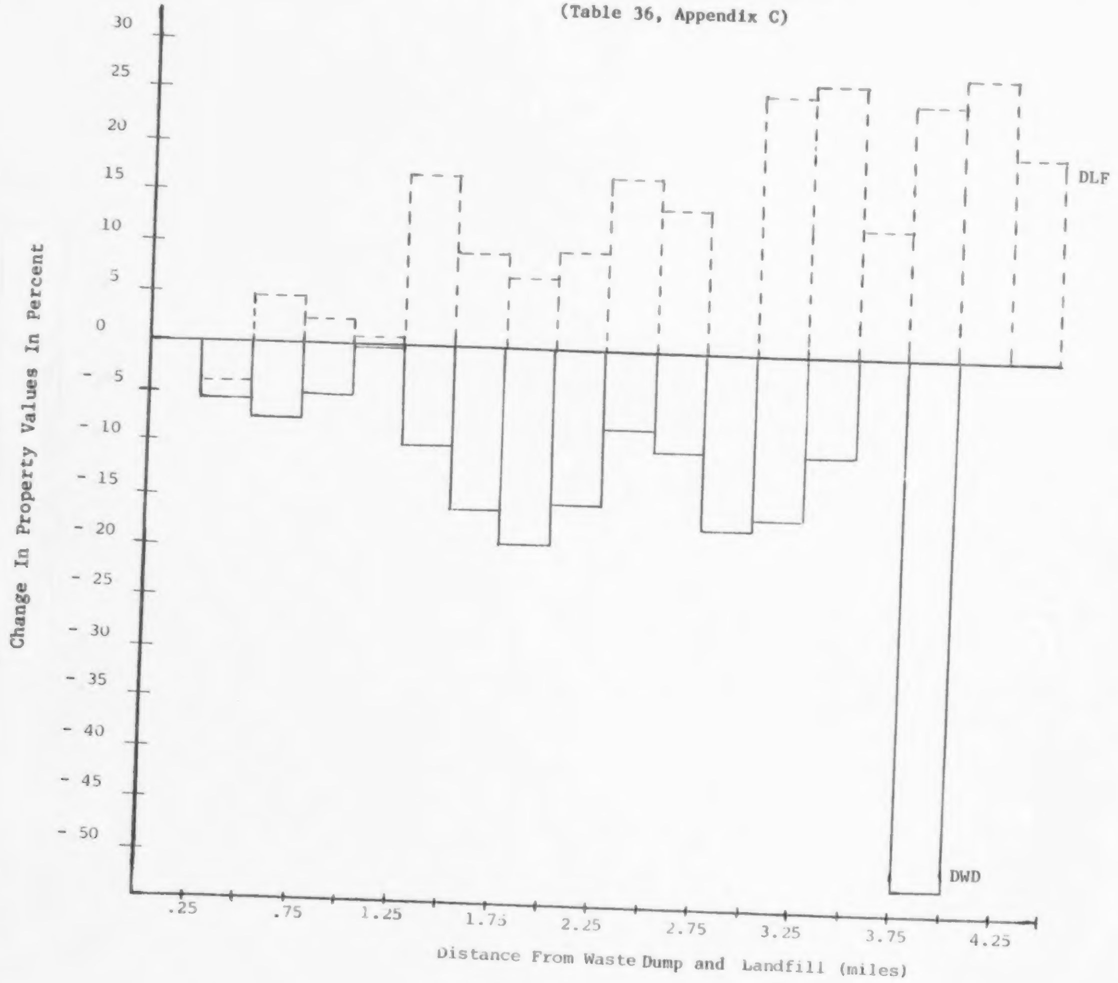


*Model B meets the specification of Model I described earlier.

Figure 6

Model B:* Distance From the Waste Dump and Distance From the Landfill Without Neighborhood Amenities

(Table 36, Appendix C)

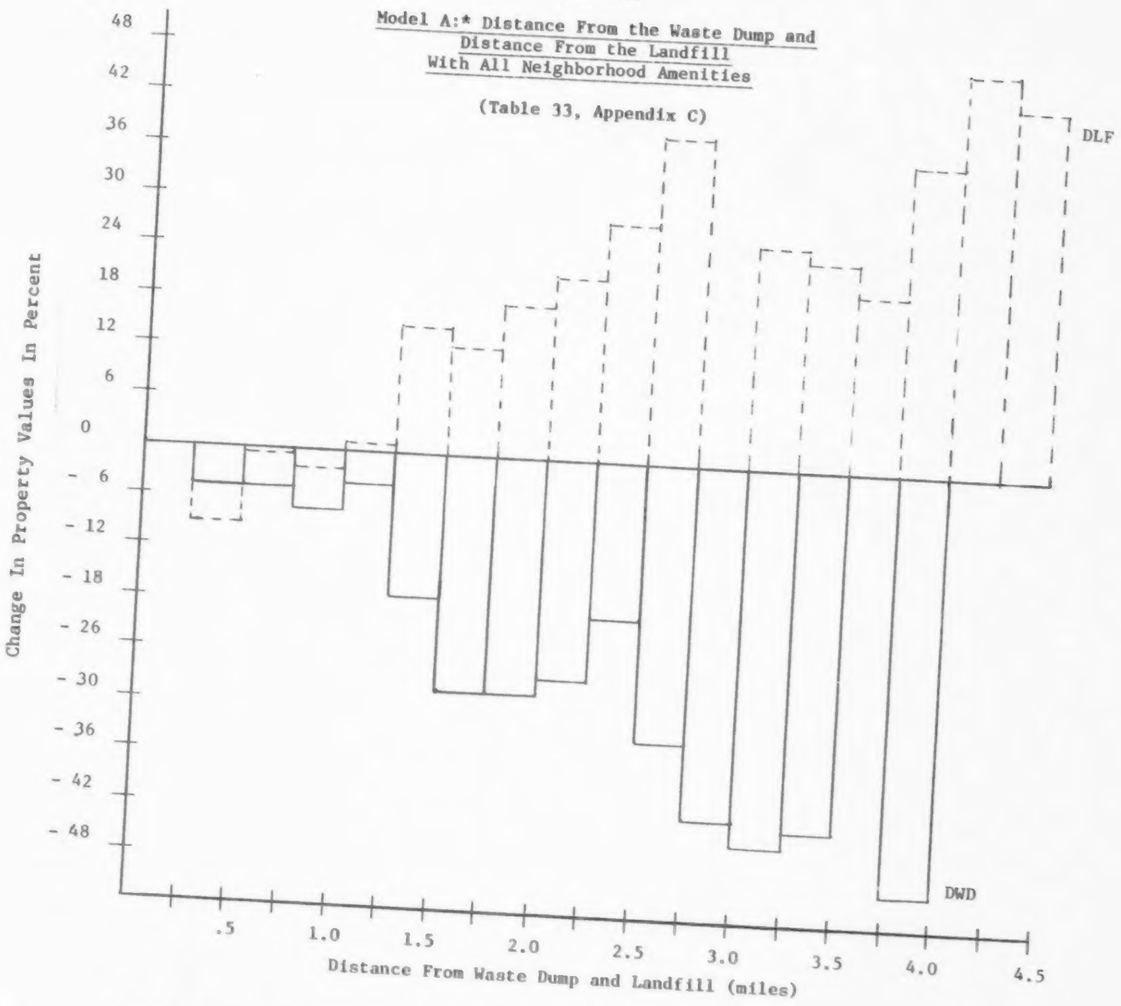


*Model B meets the specification of Model I described earlier.

Figure 7

Model A:\* Distance From the Waste Dump and Distance From the Landfill With All Neighborhood Amenities

(Table 33, Appendix C)



*Model A meets the specification of Model I described earlier.

Other specifications,[31] which include using a weighted linear term[32] of the distance from dump variable, also failed to demonstrate any systematic relationship between distance from the contamination site and property values.

Summarizing briefly the above results, one study area (Pleasant Plains) has confirmed our prior hypotheses.

- A statistically significant gradient is observed as expected for the Pleasant Plains, post-1974 sample.
- A statistically significant gradient is not observed for the Pleasant Plains, pre-1974 sample.

On the other hand, a statistically significant gradient is not observed for the Andover site. It is possible, therefore, to estimate the damages or the benefits of reducing the risks associated with contamination for the Pleasant Plains site only. However, it is not possible to do so in the Andover case.

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[31] In general, the results of variables other than the dump and landfill in the various specifications reveal that: of bathroom, bedroom, and room, bedroom proved consistently to be the strongest; housing density, housing unit density and water facility variables (MWTR, WWTR) were always statistically insignificant; junior and high school related variables were generally more significant than the high school variables, (see variable list in Appendix C), but this may be due to greater parental concern for the distance that younger children must travel; the sale date variable was usually strong irrespective of the form in which it was specified; lake view as well as housing characteristics except for basement were significant; locational variables tended to be unstable. Note from Table 30 that the R^2 was highest when neither the dump nor landfill were present.

[32] The dump variable was trended to assume a particular linear shape. The first quarter mile was assigned a value of 1 and subsequent quarter miles increased in value by 1. This is an alternative designation which serves to capture any possible effect of increases in distance on property values. The underlying assumption is that as one moves away from the source of contamination, everything else remaining constant, property values should increase.

C. Welfare Effects

Two steps are involved in measuring the damages associated with the Pleasant Plains site. The first step is to estimate the damages reflected in differential property values. The second step is to estimate total welfare losses by adding the costs of any amelioration activities.

1. Step I

Two methods for computing potential regulatory benefit estimates based on price effects were used for the Pleasant Plains site. Each method utilizes different assumptions about how the price effects generated by the presence of a hazardous waste site may be translated into damage estimates. Under Method I, it is assumed that the price changes observed in the sample of transactions used in this study (i.e., lots with residences) may be used as a proxy for damages which accrue to undeveloped land as well.[33] The potential welfare losses to owners of undeveloped lots are included using Method I. Under Method II, no assumption of this sort is made and the damages are estimated for lots with residences only. The results of these computations are presented below.

Method I	$7,819,284
Method II	$5,581,991

Computations are made by measuring the area between the post-1974 sample gradient and a hypothetical gradient which, it is presumed, reflects price differences which would be observed if the dump did not exist. The hypothetical gradient A,B is shown in Figure 8.

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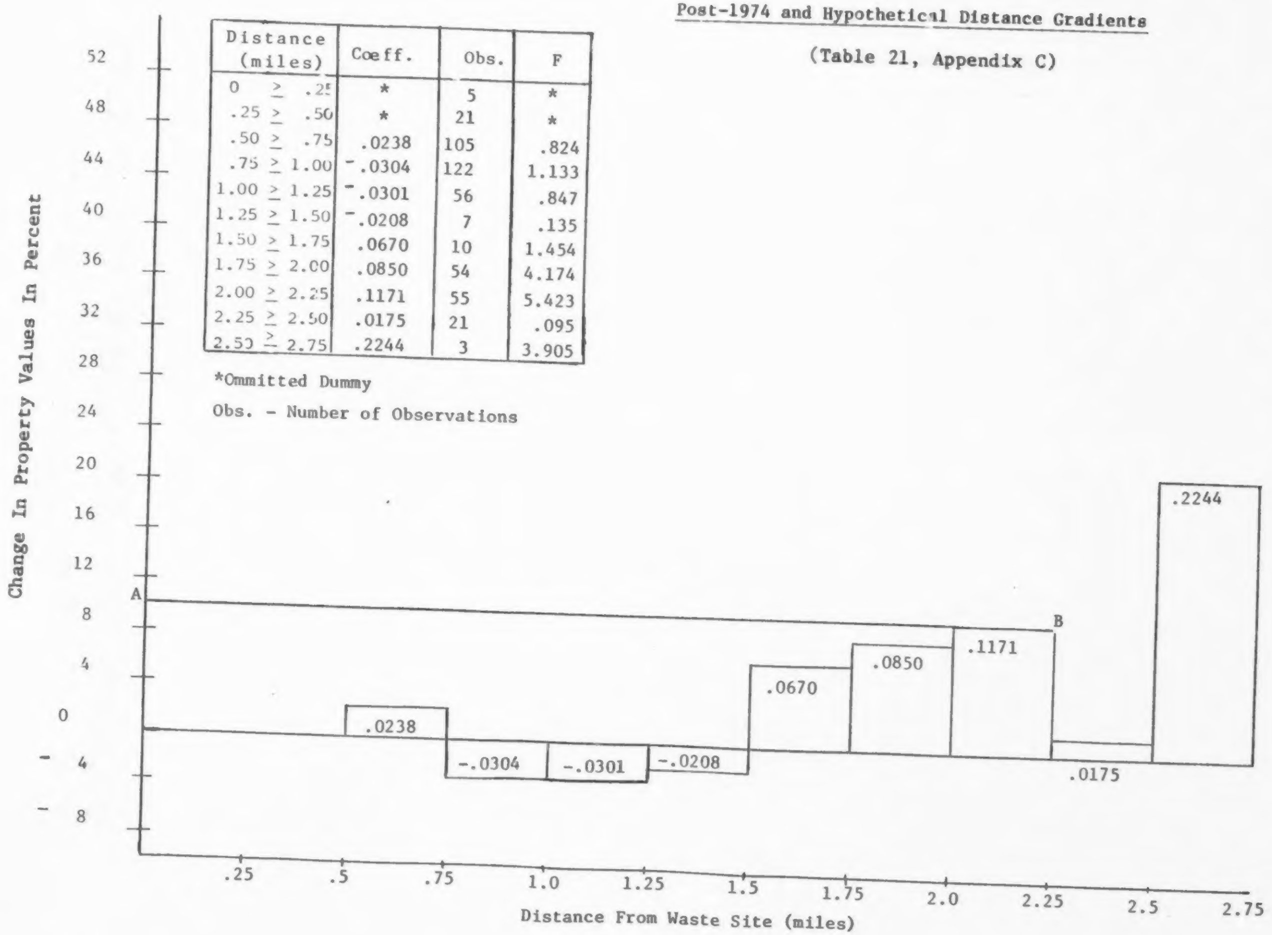
[33] It is not assumed that they may be used as a proxy for damages to commercial lots.

Figure 8

Post-1974 and Hypothetical Distance Gradients

(Table 21, Appendix C)



Distance (miles)	Coeff.	Obs.	F
0 ≥ .25	*	5	*
.25 ≥ .50	*	21	*
.50 ≥ .75	.0238	105	.824
.75 ≥ 1.00	-.0304	122	1.133
1.00 ≥ 1.25	-.0301	56	.847
1.25 ≥ 1.50	-.0208	7	.135
1.50 ≥ 1.75	.0670	10	1.454
1.75 ≥ 2.00	.0850	54	4.174
2.00 ≥ 2.25	.1171	55	5.423
2.25 ≥ 2.50	.0175	21	.095
2.50 ≥ 2.75	.2244	3	3.905

*Ommitted Dummy

Obs. - Number of Observations

The post-1974 sample gradient, as has been noted, is flat until about 1.75 miles out and increases at a fairly constant rate until 2.25 miles out after which the prices are not significantly different from price within 1/2 mile of the site. It is assumed for the purpose of ascertaining A,B that the coefficient associated with the 2.0 to 2.5 mile distance variable is close to the point at which prices are not influenced in any way by the dump, but we really do not now have enough data at this distance to be certain.

Damage estimates range from an average of $5,367 per house close to the dump to an average of $1,471, 1.75 miles away.

The actual computations are made in the following way:

a. The percentage increase in house values from the base (1/2 mile away) are calculated for each 1/4 mile zone.[34]

b. The number of lots with houses are calculated for each 1/4 mile area.

c. The number of vacant lots are added to the number of lots with houses for each 1/4 mile area.

d. "a" is multiplied by the base house price[35] (i.e., $45,836).

e. "c" is multiplied by "d" (This generates Method I estimates).

f. "b" is multiplied by "d" (This generates Method II estimates).

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[34] Each coefficient is subtracted from .1171 (the coefficient associated with observations 2 to 2.5 miles out). Those that are not statistically significant because of the way the gradient has been specified, i.e., they are not significantly different from the ommitted dummy variables close to the waste site, are assumed to have the same zero value.

[35] From the regression equation it is possible to compute the mean house prices in the area within .5 miles of the site by deducting from the mean of the dependent variable the sum of the weighted means of the coefficients of each quarter mile dummy variable.

2. Step II

The gross damage estimates include the costs borne by public and private agencies, including private firms, to ameliorate the problems experienced by property owners as a consequence of the dumping episode and/or to forestall potential future damages. Table 4 lists the estimates of costs that had been made by the New Jersey Environmental Protection Agency and that were available for our use. Before an adjustment can be made for deducting compensation paid by the private firm responsible for the incident[36], separate estimates are presented, one with compensation deducted and one with compensation ignored.

Total Damages (Damage reflected in differential property values and costs associate with amelioration.)

Using Method I (and excluding compensation)	$7,905,584
Using Method II (and ignoring compensation)	$8,115,584
Using Method II (and excluding compensation)	$5,668,291
Using Method II (and ignoring compensation)	$5,878,291

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[36] This issue may be argued either way. On the one hand, compensation implies that the full burden of the externality is not borne by the householder or the publc agency, in which it should be deducted. On the other hand, since compensation of the sort paid by the private firm responsible for the dumping took the form of a lump sum transfer to present owners, it may not be expected to reduce the capitalized welfare loss measured by the price changes.

Table 4[1]

Estimates of Costs Incurred to Reduce Damages Potentially Done by Households[2]

(in dollars)

Clean Up Costs of Union Carbide	Unknown
Inspection or removal of drums	$ 10,000
Interim emergency water supply	4,900
Extension of public water supply	234,200
Cost of sampling and analysis	38,900
Construction of observation wells	8,300
TOTAL (ignoring compensation)	$296,300
Compensation	$210,000
TOTAL (excluding compensation)	$ 86,300

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[1] Data derived from M. Ghassemi, Analysis of Land Disposal Damage Incident Involving Hazardous Waste Materials, Dover Township, New Jersey, May 1976.

[2] The costs of capping wells, drilling new wells and the increased annual costs of water fell on the owner. These costs would, therefore, be expected to be reflected in property values.

VI. FURTHER DISCUSSION

The results generated in our analysis of the two sites seem to be consistent both with the prior hypotheses and with the known facts and anecedotal evidence collected about both cases. Anecdotal information obtained mainly from residents, collected at the time and in the course of our investigation, supports the empirical evidence presented in this study that house values were affected by the disposal of hazardous wastes in Pleasant Plains. The results of the Andover sites are also consistent overall with similar anecdotal evidence.

A. Pleasant Plains

The fact that in Pleasant Plains, property values did not respond more markedly to the incident may be explained by the speed at which intervention occurred--the site was cleaned up before 1974, and a municipal water supply was installed and connected within a month of the discovery of contamination. Another factor possibly mitigating against a larger price effect is the lack of any demonstration of contamination in Pleasant Plains since 1976.[37] This suggests that the impacts of the dump site on Pleasant Plains could have been short-run, rather than long-run. However, we found the price effects to be more lasting, extending throughout the period for which the sample 1 data were collected.

On the other hand, there may be actual or feared health risks involved with living in an area in which the groundwater is contaminated. Further, public opposition to the sealing of private wells suggests that there are some damages other than those which would be incurred by installing a municipal water supply, etc.

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[37] Recently contamination was discovered just north of Pleasant Plains.

The exact nature of these perceived damages is not known. Distance and zones of contamination were used in this study as proxies for the damages affected by hazardous waste sites. They do not reflect which of the possible effects property values reflect, i.e., individual well contamination, contamination in the area, the loss of the preferred private wells, etc.

It would be possible to specify distance or contamination proxy variables to provide more information on the specific nature of the perceived damages. However, more detailed data would be required on the specific wells contaminated to improve the contamination variable. An alternative approach would be to allow the distance variable more flexibility so that it could more accurately describe the pattern of response to contamination. In the study, distance was expressed in concentric circles. Yet, there is no reason to believe that contamination moves at the same speed in all directions.

B. Andover

The results of the Minneapolis site are also consistent overall with other kinds of evidence collected during the period of study. It has been concluded that the analysis failed to produce the necessary statistically significant results that would demonstrate that property values close to a site of contamination will be permanently impaired, irrespective of whether contamination is widespread.

Several possible explanations of this result may be put forward. One is that the current contamination is not very substantial, nor is it even perceived to be an immediate threat at all. So far only 3 wells, all of which are located on the same property as the hazardous waste site, have been found to be contaminated. Of the compounds detected, only 3 are present in concentrations that exceed levels judged to be safe for human tolerance. They are: Methylene Chloride; Perchloroethylene, and Xylene.

Perhaps the primary factor in maintaing property values is that the 3 contaminated wells all draw on shallow aquifers, whereas the wells in the surrounding communities draw on different aquifers.

The current state of knowledge also implies that the possibility for extensive groundwater contamination exists, but its future contamination depends on the types of seal that are used to finish the surrounding wells. Further investigation of such issues are contingent upon steps taken by the U.S. Environmental Protection Agency. These tests should establish the extent of current contamination and the direction and speed of the spread of contamination.

The relative strength of the landfill variable (compared with the waste dump variable) could be a function of prior knowledge of the landfill as a garbage facility. The landfill is owned by a statewide garbage disposal service and has been in existence for 30 years. Hence, there has probably been some capitalization effect of the negative externality associated with garbage.

On the other hand, the association of the dump site with hazardous waste is relatively new and residents simply may not have adjusted as quickly as was expected. Other factors, such as the frequency with which hazardous waste sites are discovered and their prevalence in this part of the country, could numb residents to further news on the subject where there appeared to be no immediate threat. Moreover, the containment of the contamination to the property of the dump owner has perhaps influenced the perception of residents as to the potential hazards.

VII. CONCLUSIONS

Several conclusions with respect to the effects of hazardous waste sites on property values may be drawn from the empirical evidence accumulated in this study.

From our analysis of the theory, it has been demonstrated that there should be a link between property values and hazardous waste sites. Further, the approach has been shown to have merit insofar as it can be used to obtain reasonably reliable benefit estimates.

While there is no established theory linking distance and risk, distance has served in this study as a proxy for the impacts of the hazardous waste site. It was found to be more useful than the officially defined zones of contamination. Indeed, the officially denominated zones of contamination in the study have been found to be unreliable. The problem of defining such a zone seems to be complicated by inconsistent monitoring results.

Of the empirical results, those for Pleasant Plains were determined to be consistent with the hypothesis, i.e., a statistically significant gradient was observed from the source of contamination in the sample of sales transacted after the contamination episode. Further, no statistically significant gradient was observed in the sample of transactions made before the contamination episode.

The results for the Andover sample are not consistent with the hypothesis, but this may be because the problem at Andover has been relatively insignificant so far.

APPENDIX A

Land Value Theory

by

Robert C. Anderson

and

Roger C. Dower

Preface

Appendix A constitutes the foundation for the theoretical discussion in Chapter II. In this capacity, it analyzes the theoretical basis for studying the relationships between land values and proximity to a hazardous waste site. It does this by examining the strengths and weaknesses of theories which explain the relationship between environmental quality and land values and by examining specific methodologies used in empirical investigations of this relationship.

In another dimension, this Appendix serves as a literature review and thereby provides a starting point for the empirical investigation.

I. INTRODUCTION

The disposal of hazardous wastes is a complex subject that has attracted the attention of lawmakers, governmental regulatory agencies, the media and the public. Although the interests of these groups vary, two generic policy issues have surfaced:

1. Certain existing disposal sites pose threats to human health and welfare. What level of remedial action or compensation to the victims is appropriate?
2. New facilities create a disamenity when located in or near an urban area. What types of controls should be used to avoid undesirable risks to health and welfare and what payment is needed to compensate nearby residents for the disamenities associated with the facility?

These questions involve one common theme: the need to measure the benefits of reduced risk from the disposal of hazardous waste; in other words, the damages from exposure to the risks of hazardous waste disposal. Economists have identified several distinct conceptual approaches that, in principle, could be used to measure the relevant benefits or damage functions for non-market commodities like health and environmental risks. One method is to measure current and anticipated physical damages and then place appropriate economic values on these effects. A second method is to survey individuals directly concerning the amounts they would pay to reduce risk or the compensation they would demand to bear greater risk. A third approach is to analyze voting behavior when decisions such as hazardous waste siting are subject to a referendum. A fourth method uses prices in related markets to infer the values individuals attach to non-marketed goods and services. An example of this approach is the use of property values to estimate the value of different characteristics of properties, including proximity to hazardous waste facilities.

This study focuses on the last approach--the use of property values--to estimate the values individuals attach to risks and other disamenities associated with proximity to disposal sites. Two hypothetical situations help to clarify the approach. First, suppose a hazardous waste facility is sited in a remote area far from residential neighborhoods. Through the processes of urban growth, surrounding land is slowly developed until new residences are being constructed in close proximity to the waste facility. Most people would likely deny that those buying new residences in the area merit compensation for the disamenity, providing they were informed before purchasing. On the other hand, it is often politically important to know the extent to which property values will be affected and how to interpret any measured impacts.

The second situation involves the siting of a hazardous waste facility in an industrial park within close proximity to an established residential neighborhood. Some residents will find their satisfaction diminished. If the transaction costs of moving are not too large, they may offer their homes for sale and attempt to find a replacement home without the disamenity. Even if transaction costs do inhibit some from moving, other residents will leave the area as a normal consequence of corporate transfers, retirement, and divorce. To whom will these homes be sold? Assuming individuals are not homogeneous with respect to tastes and preferences, the homes will be purchased by those who place the smallest negative value on the disamenity, for to them discounts from prevailing price levels will make the properties seem to be a bargain.

To others with less tolerance for the disamenity, the property may seem grossly overvalued relative to other alternatives on the market.

Several observations can be made regarding this example. First, changes in price tend to reflect changes in value to those individuals who are least sensitive to the disamenity, not the change in value to the average person. Second, changes in price may not reflect actual losses to existing owners for reasons that include transaction costs of moving and anticipation by some owners prior to their actual purchase that a facility would be located nearby. Third, multiple sources of amenities and disamenities in the neighborhood may make it extremely difficult to sort out the separate impacts of a nearby waste facility.

The remainder of this Appendix is divided into three major sections. The next section is devoted to a fuller treatment of the links between environmental quality and property values, by reviewing theory linking the two, examining various alternatives for measuring impacts and reviewing several empirical applications. The third section of this paper examines more fully the issue of using property value changes as an indicator of benefits or loss of benefits. Both theoretical and empirical applications are reviewed.

The last section discusses the potential for applying property value analysis to the siting and control of hazardous waste facilities. The section notes special characteristics of hazardous waste disposal sites that make property value analysis for them more complex than the existing empirical applications for noise, solid waste disposal, and air and water pollution. The section concludes with descriptions of a set of two interrelated studies to determine the impacts, if any, of hazardous waste disposal facilities on nearby property values.

II. LINKING ENVIRONMENTAL QUALITY TO PROPERTY VALUES

To argue that property values can reflect the economic benefits of varying levels of environmental quality, it is necessary to establish first how environmental quality affects the land market. Perhaps the simplist way to visualize this relationship is to consider land prices for specific parcels as the discounted stream of net benefits attributed to each parcel. Observed market prices reflect transactions among individuals, the transactions resulting from the different values attached to the property by the buyer and the seller. To the extent that environmental quality affects the net benefit stream received from holding a parcel, the value of the parcel to the owner will rise or fall. For example, an increase in pollution levels in an area, everything else held constant, should decrease the net benefits of residential property (benefits fall or costs rise depending upon the point of view taken). Everything else being equal, one would expect that the price for the residence would be lower in the presence of greater amounts of pollution.

This relationship can be stated more formally in terms of the utility functions of land market participants. If environmental quality affects the utility derived from purchases of land or if environmental quality enters directly into individual utility functions, property values may be affected. Either situation is sufficient to ensure that environmental quality appears as a factor in the demand for housing and, therefore, the choice of residential location. This view is consistent with the recognition that housing is a heterogeneous commodity, a collection of characteristics that are distinct to some degree. That is, the demand for housing is dependent on such characteristics as the number of rooms, distance to recreation or work, building material, and environmental quality.

In attempting to validate empirically the relationship between property values and environmental quality, most analysts have applied the technique that is now termed "hedonic theory." This theory shifts the focus of housing demand analysis from commodity housing to its underlying characteristics, including environmental quality. Much of this section will be devoted to a description of hedonic theory and its empirical application.

A. Hedonic Theory

Hedonic theory begins with the utility function of households,

(1) $U = U(X,H)$

where X is a vector of private goods excluding housing, and H is a vector of housing attributes or characteristics. The utility function is taken to be quasi-concave and continuous in first and second partial derivatives. The budget constraint for a representative household is:

(2) $PX + ZH = Y$

where P is a vector of private good prices excluding housing and Z is the hedonic price function relating housing prices to their characteristics.

The consumer's choice process over housing can be represented by a two stage process. First, the consumer maximizes utility subject to the budget constraint with housing consumption held fixed. This produces what has been termed an indirect utility function.

(3) $F[P,Z,Y - Z(H)]$

This function determines the maximum utility that the consumer can obtain, given the prices of market goods, when he resides in a dwelling with characteristics H costing the amount Z(H). In the second stage, the consumer chooses houses that maximize the indirect utility function (3). The focus of hedonic theory is on the function Z(H), or the hedonic price function, which depicts the individual prices z_i for characteristics h_i. A subsequent section will deal with the problem of identifying and estimating demand functions for the characteristics.

The coefficient z_i of the hedonic price function represents the additional amount that must be paid on the average property to acquire an additional unit of characteristic h_i, holding everything else fixed. For example, a linear hedonic price function for housing might be specified as:

$$(4)\ PV = ZH = z_0 + z_1h_1 + z_2h_2 + z_3h_3 + \ldots$$

where:

PV = the property value

h_1 = house size in square feet

h_2 = distance to central business district

h_3 = a measure of environmental quality

z_i = the price of one unit of the i^{th} characteristic

The equation is not observable directly, but can be estimated statistically from data on market transaction prices for properties. The estimated coefficients z_i can be interpreted as implicit prices. For example, z_3 could be taken as the price of a unit change in environmental quality for the average property in the sample.

It is important to note that implicit prices will only be reflected in the land market for those goods that people can evaluate. In terms of environmental quality only those characteristics that are reasonably well known or understood will be capitalized in land values. It is not necessary, though, that there be a direct relationship between a physical damage function and individual utility functions. It is sufficient that market participants associate a particular land parcel with particular environmental quality characteristics. Nevertheless, to the extent that land market participants are poorly informed on environmental quality or do not detect certain environmental effects (such as chronic health effects), implicit prices for environmental quality will be downward biased. The critical role played by information in hedonic property value studies will be discussed further in the section on hazardous wastes.

B. Applications of Hedonic Analysis to Property Values

Literally dozens of papers have used some form of hedonic analysis in attempts to exploit its ability to isolate the importance of various factors that explain property values. Frequently, the principal focus of the studies was not of particular interest to the subject of this paper. Consequently, this review ignores many of the papers where the principal focus was on topics such as the price or income elasticity of demand for housing.

An early example of hedonic price analysis is offered by Ridker and Henning (1967). They used a hedonic regression to explain property value differences among census tracts in St. Louis. Included among their explanatory variables were neighborhood characteristics and measures of air pollution. They interpreted the coefficients of their air pollution variables as measures of the willingness to pay for an overall reduction in air pollution in St. Louis. At least 15 subsequent studies have examined the relationship between property values and air pollution.

These studies provide some validation to the hypothesis that environmental quality affects property values. Of the 15 studies reviewed in Freeman (1979), 12 show air pollution as having a depressing effect on property values, as expected. In some cases, the results are remarkably similar, given the different data bases, model specifications, and variable definitions. For example, the Anderson-Crocker (1971) and Polinsky-Rubinfeld (1977) studies both used property values by St. Louis census tracts in 1960. Their pollution variables were the same, but the remaining explanatory variables differed slightly. Their results for owner occupied property value impacts implied a composite elasticity (for sulfation and particulates) of .1 to .2.

Several studies have examined the effect of nearby non-residential land uses on the price of residential properties. Although the results of the studies are mixed with some showing a price effect and others showing no effect, the studies do provide useful insights for modeling the relationship between hazardous waste disposal activities and residential property values.

Havileck, et al., used a hedonic price function to estimate the external effects of solid waste disposal sites (landfills) on property values. Sales prices of single family homes, over the period 1962-1970, around five waste disposal sites were regressed on variables describing the physical attributes of the housing, the year of sale, the distance from the nearest disposal site and the downwind direction from a site. Dummy variables were also included to account for differences among the disposal sites. The estimates from the regression indicated that for every one foot difference in distance from a property site, values increase on the average by \$.61, and for every degree away from the downwind of a site, values increase by \$10.30.

A study by Crecine, et al., found that for a number of areas in Pittsburgh there was no systematic evidence that the value of single family homes was affected by the presence of nonresidential land uses in adjacent land use blocks. Their explanatory variables included the percentage of various nonconforming land uses--such as two-family residences, multiple family dwellings, retail stores, commercial services, cemeteries and vacant land. Similar results were obtained by Reuter using a better data base.

Kain and Quigley found that data from St. Louis indicated that the presence of commercial and industrial structures on a parcel's block face had a statistically significant negative effect on the price of single family houses and apartment rents. Stull found that for a sample of 40 suburban towns in the Boston SMSA, multiple family use and industrial land use had a negative effect on single-unit, owner-occupied homes.

Grether and Mieszkowski used data from New Haven and surrounding communities to examine the effect of several types of nonresidential land use. The authors were careful in their choice of sites for the separate "experiments" to find areas affected by only one nonconformity to single-family use. Included as "experiments" were properties surrounding an elevated turnpike, commercial strips, industrial development, multiple family housing units, and small commercial developments. They chose a semilogarithmic specification largely because of simplicity (the natural log of value was regressed on observed values of the explanatory variables). In that specification, each separate explanatory variable adds or subtracts a constant percentage amount from value. Their data spanned the years 1954-1970. To account for changes in price over the period they included a time trend (specified as three separate rates of growth for the periods 1954-1958, 1959-1963, and 1964-1970). Proximity to the source of nonconformity was specified as distance and the square of distance. Sample sizes ranged from 76 to 383 in the 16 separate experiments. The authors felt that some of the samples were quite small for this type of analysis and claimed not to be surprised that the distance variable was significant in only five of the experiments at the .05 level and in only three of the experiments at the .01 level. They concluded that non-residential land use, per se, did not have a systematic effect on values in their samples.

Two other recent papers on hedonic price functions considered explicitly the effect of non-residential uses. Jud developed a variation of the hedonic price model to investigate the effects of zoning and neighborhood land uses on the value of single family residences. His model differs somewhat from the typical specification in that the dependent variable is defined as market price per square foot of structure rather than simply market price. Jud's rationale for this specificaiton was that it gave more consistent results; he did not offer any theoretical rationale to support the specification, however. The neighborhood land uses that were investigated included industrial, commercial, and vacant. A quadratic functional form (X_i and X_i^2) was estimated for each neighborhood land use variable to allow for the possibility of a nonlinear relationship. As a rationale, Jud notes that a few commercial establishments nearby might lower property values because of congestion but a large shopping center could actually enhance values.

Jud used a sample of 3,513 transactions--all of the single family sales in the city of Charlotte, North Carolina, for the year 1970. He estimated both a linear and a semilog model. For both models the neighborhood variables, percentage of land devoted to commercial and industrial use, and the square of these variables were significant at the .05 level.

Li and Brown estimated a hedonic price model that focused on the effect of micro-neighborhood externalities on the price of single family homes. They postulated that such micro-neighborhood characteristics as proximity to a grocery store, a river, a neighborhood park or conservation land would have two types of effects: a positive price effect associated with accessibility to a desired non-residential activity and a negative impact arising from congestion, air pollution and noise. They anticipated that the sum of the two effects would produce a net positive effect that increased with distance up to some most-valued location and then declined monotonically thereafter toward zero.

The Li and Brown study obtained a sample of 781 sales of single family homes in the southeast sector of the Boston metropolitan area from 1971 records of multiple listing real estate firms. Sales price was hypothesized to be a function of (1) structure and site characteristics, (2) neighborhood characteristics, (3) local public service and costs, (4) accessibility to the central business district of Boston, and (5) micro-neighborhood characteristics such as pollution, aesthetics and distance to nonresidential activities. The authors devoted most of their attention to a linear specification, using sales price as the dependent variable. They also noted that if all characteristics of size are multiplicative in their effect (e.g., doubling size doubles the effect of an extra bathroom) and the error term is proportional to size, the equation can be estimated with price per room or price per unit of land area as the dependent variable and all other explanatory variables as per the initial specification.

The empirical results confirmed their hypothesis regarding the two opposing effects of micro-neighborhood externalities. For distance to industry, to commercial areas, and to the major thruway both the positive effects of access and the negative effects of congestion, noise and pollution were significant (or nearly significant) at the .05 level.

A final example is Nelson's paper which investigated the impact of the Three Mile Island nuclear accident on residential property values around the plant. Specifically, he was interested in determining whether the accident resulted in a statistically significant decrease in housing prices within five miles of the plant. His hypothesis was that lasting long-term concerns resulting from the accident would be reflected in a dimunition of land prices. Nelson's two-part study first analyzed, within a hedonic price framework, housing prices in two small communities surrounding the plant over a two-year period before and after the accident. The second section statistically analyzed all sales price data within five miles of the plant and compared rates of change with outside and control estimates. We focus here on the first section as being more directly relevant to our questions.

Nelson's hedonic analysis utilized samples of 47 and 53 observations, respectively, for the two communities. Observations on housing sales were collected from county assessment cards and covered the period January 1978 through December 1979. The nuclear accident occurred on March 28, 1979. For the first community (Oak Hills) there were 19 sales after April 30

(Nelson assumed that any sales between March 28 and April 30 were agreed to before the accident). Valley Green Estates, the second community, had 22 "after" sales.

The model used by Nelson was:

$$SP = a_0 + a_1X + b_1T + b_2(TMI) + b_3(TMI.T) + U$$

In this specification, SP is the sales price and X is a vector housing characteristic. For the Oak Hills equation these variables included square feet of living space, lot frontage, and dummy variables if the house was semi-detached, had a basement, had a brick exterior, had certain housing extras, or if the house was built after 1974. The T variable is a trend variable taking on a value of 1 for the first quarter of 1974, and so forth. It was intended to capture general changes in market prices over time. The TMI and TMI.T variables are dummy variables to test for possible shifts in the slope or constant term of the equation after the accident. TMI equals 1 if the sale was after April 30, 1979. It is noteworthy that a distance variable was not included in the equation (the implicit assumption was that properties would be affected similarly by the accident regardless of the exact distance from Three Mile Island).

Three equations were estimated for both communities; one equation included both TMI and TMI.T and the other two equations included the variables separately. In general, the estimated coefficients for the housing characteristics carried the expected positive signs and were significant at the 95% confidence level (one exception was the dummy variable for semi-detached homes which was negative and insignificant). On the other hand, not one of the TMI variables was statistically significant. Nelson interpreted this result to suggest that the accident could not be associated with a change in housing prices.

Nelson suggests three reasons why his model was unable to detect a property value effect of the accident: (1) there is the possibility that the time period covered by the analysis was too short to allow market adjustment; (2) residents may have perceived the costs of the accident as being short-run in nature; (3) the residents may have expected federal and state assistance, the positive effects of which may have offset any negative impacts from the accident.

Nearly all of these studies have discussed to some extent the specification of the hedonic price equation: the variables to be included and the functional form of the equation. While there seems to be general agreement about the proper variables to include, the proper functional form has not been agreed upon. Some authors prefer a linear form and others a semi-logarithmic form. Some use a dependent variable expressed simply as sales price, while others use price per unit land area, price per unit house area, or price per room. Halvorsen, Pollakowski, Ellickson, and Bender, et al., have all developed flexibile estimation procedures patterned after Box and Cox which permit comparison of many alternative specifications. Their work shows that the coefficients can be sensitive to the specification that is chosen.

C. Time Series Approaches

An alternative to cross-sectional methods for estimating the effects of changes in environmental attributes on property values is to compare property values before and after a change in environmental quality. An early example of this approach is Ridker's 1967 study which used both time-series and cross-sectional approaches to estimate air pollution control benefits. However, pure time-series analysis has not been used often to measure the value of environmental amenities, principally because of the difficulty of controlling other time-related influences on property values. There may be instances, however, where this technique would be appropriate.

Critical to the use of a time-series approach is the development of a real estate price index. A useful reference on this point is the review of Palmquist which compares results of two methods, one using pairs of transactions on the same properties and the other, a hedonic equation on different properties with time as a characteristic.

Several of the studies reviewed earlier in this section used time as a characteristic in cross-sectional regressions of housing prices on housing attributes. Some analysts have questioned this approach because the hedonic price equation may be misspecified or incompletely specified. Thus, the estimated variation in prices over time (as in this study of Three Mile Island) may err because important variables that are correlated with time (such as the size of new dwellings) have been omitted. The alternative approach to measuring changes in prices over time relies on pairs of transactions for a sample of properties, thus holding quality fixed. Palmquist also improved on past studies using the repeat sale approach by incorporating a factor for depreciation. He showed for his sample that without the depreciation correction the hedonic and repeat sale methods yielded statistically identical results. When depreciation is considered, the two methods differed in their estimate of price changes over a 15 year period by as much as 7 percent.

Another example of time series analysis of property value changes is Anderson and Dower's analysis of the impact of land use controls imposed by the Adirondack Park Act in New York. In this study, price indices for land values in different land use classes were estimated using repeat sales data for periods before and after passage of the Act. They found that the more restrictive the land use controls, the greater was the impact of the 1973 Act on property values.

Up to this point, the emphasis has been on different attempts to isolate the property value impact on the implicit price of a particular land characteristic such as environmental quality. Although these impacts may be of great political interest, from an economic or policy viewpoint the benefits of environmental quality is of more significance. A growing, and still controversial, body of literature concerns how the implicit prices obtained from a hedonic price function can be used to estimate benefits. The next section presents a general overview of the major issues.

III. ESTIMATING BENEFITS

Early on, Rosen showed that the indirect utility function, given by equation (3), could be given a useful interpretation in terms of the consumer's marginal willingness to pay for characteristics of a composite commodity. The coefficient of the characteristic in the hedonic price function can be interpreted as the marginal willingness to pay for an additional unit of the characteristic.

If marginal willingness to pay can be taken as constant for all units of a characteristic and all households have the same tastes and preferences, benefits can be derived directly for a given change in the amount of a particular characteristic that is supplied. This set of assumptions is relatively common in the literature that attempts to derive benefit estimates for changes in environmental quality using the hedonic approach.

An example of a study using this approach is Barnard's analysis of the impacts of increased flooding probabilities resulting from urban development in Iowa City, Iowa. Barnard estimated a hedonic price equation for single family residences in the area and took the coefficient of the flooding probability as a measure of a constant marginal willingness to pay to reduce the chances of flooding.

Another similar example is given by Brown and Pollakowski. They developed a hedonic model to estimate the impact on property values of proximity to urban shoreline and the effects of buffer zones of undeveloped land surrounding lakes. The policy question of interest to them was the ability of regional planners to determine the optimal amount of undeveloped land to provide thorough zoning restrictions or public purchase of land surrounding lakes. To answer this question the authors first developed a hedonic equation for property characteristics. In the second stage, they assumed marginal willingness to pay was constant and that all households were identical in taste and preferences.

The Brown-Pollakowski hedonic price model estimated the implicit prices for housing attributes, including proximity to lakes and depth of open space surrounding the lake, for homes around three lakes near Seattle. One of the lakes was surrounded by a setback (or buffer zone) of varying width while the other two had no setback. The sample areas were chosen for their high degree of neighborhood homogeneity, easy access to the lakes, and variations in setback width.

The authors used data on market sales for residences around the lakes during the years 1969-1974. Sales data and descriptions on housing attributes were obtained from monthly publications of the Seattle Real Estate Association Market Data Center, Inc. The basic equations estimated for the three areas (the two samples with no setback were pooled into one equation) were linear expressions of sales price (deflated to 1967 dollars) as a function of living area; age of house; average room size; number of fireplaces; number of car garage; number of first floor rooms; number of bathrooms; dummy variables for the existence of a basement, dishwasher, range or oven, wall or floor heating, and electric heating; distance to waterfront; and individual setback size. These last two variables were included in log form. The authors argued that the relationship between sales price and distance or setback size was non-linear. Specifically, they assumed that as distance or setback width increased, the sales price premium increased at a decreasing rate.

The estimated coefficients of the two equations were generally of the appropriate sign and statistically significant. The R^2's were .84 and .78 for the setback and non-setback samples, respectively. The coefficients of the setback width variable indicated residences adjacent to 200 and 300 foot buffer zones would sell for approximately $850 and $1,350 more than one located next to a 10 foot zone. The estimates also showed that distance premium decreased more quickly in the non-setback equation than the setback sample.

The regressions results were used to provide rough estimates of the benefits from open space by interpreting the marginal implicit price function as marginal willingness to pay. That is, the derivative of the hedonic price equation with respect to setback width was taken as the demand curve for open space around lakes. This transition required several assumptions: first, that the housing characteristics were unique to home purchases and that buyers and sellers utility function were weakly separable in housing services; second, that there is a high degree of inter-urban area mobility; third, that households have equal incomes; finally, that households have identical utility functions. Given these assumptions, Brown and Pollaskowski were able to estimate benefits to homeowners, the added value to property caused by marginal changes in the width of setback. Optimal open space was then estimated by comparing the benefits to the costs of providing additional open space. The results of the study were used by the authors to justify subsidies for private efforts to establish open areas or government intervention to provide public areas around water bodies.

Rosen and Freeman (1974) have argued that the coefficients of the hedonic price equation are actually points of equilibrium between the supply of particular characteristics and the demand for the characteristics. One special case that makes identification of the demand curve easier is if all households have the same income and taste so they can be represented by one willingness to pay curve. Then the willingness to pay curve is simply the marginal implicit price function. This assumption was made implicitly by Ridker and Henning and has been explicit in the studies of Brown and Pollakowski, Barnard and others. A second special case simplifies the estimation of demand for attributes if supply is fixed. Then the marginal implicit price function is the inverse of the demand function. This is the approach taken by Harrison and Rubenfield (1978).

If supply is fixed, and the other assumptions concerning the constancy of marginal willingness to pay and identical utility functions are satisfied, the simplified procedure of Brown and Pollakowski, Barnard, and others would be valid. But supply cannot necessarily be assumed to be fixed. Neither is it necessarily reasonable to assume that all households have identical incomes and identical utility functions. Rosen and Freeman argued, in essence, that for the more general situation, demand curves for separate characteristics could be derived from the coefficients of the hedonic price function. The basic procedure is as follows.

In the hedonic price function, specify a nonlinear relationship between price and the attribute of interest (a linear relationship would provide no price variation and no hope of identifying demand equations).

From this estimated relationship for the price of the attribute of interest, generate a "price schedule" for all homes (or census tracts) in the sample. With this price schedule and observations on the quantity of the attribute that is consumed, household income and other taste shifters such as education or age, estimate a demand equation for the attribute of interest.

Nelson (1978) took a somewhat different approach in actually specifying a supply function. The two equation model Nelson used to generate demand curves for improved air quality has been criticized as ignoring some supply-side adjustment process. A more recent simultaneous equations study by Witte, et al., (1979) looked more closely at the supply side in their housing market study. Although they developed and estimated an intersecting simultaneous system, it did not include environmental quality parameters.

The procedure outlined by Rosen and Freeman has been criticized in some as yet unpublished papers (see Mendelsohn, for example). The argument is that the hedonic price function estimated from cross-sectional data identifies a price schedule for different quantities, but not true price variation. Only one point on each willingness to pay function can be obtained. Thus, the second stage estimation process is probably not producing valid estimates of demand for attributes but merely rearranging the information in the hedonic price equation.

IV. APPLICATION TO HAZARDOUS WASTE SITES

In the most general sense, the regulatory interest in hazardous waste sites involves the potential risk to human satisfaction and the environment. The issue to be addressed in this section is whether risks from these sites and willingness to pay to reduce the risks can be measured from property values. Following most of the studies discussed earlier, the actual manner in which risk enters individual utility functions will not be investigated. Rather, it is assumed that risk affects utility through identifiable characteristics of properties. A more definitive treatment of risk is usually not encountered in empirical studies of property values and is beyond the scope and needs of this study. By way of introduction, it is useful to highlight two special characteristics of hazardous waste problems that will affect any property value study.

A. Routes of Exposure

The potential for adverse effects from hazardous waste disposal results from the possibility of human or environmental exposure due to leaks, spills or explosions from improper handling of the wastes or accidents. These events are translated into exposures when the wastes come into contact with humans or the environment through contamination of air, ground and surface water or soil. For example, of 169 remedial action sites studied by EPA, 110 sites were associated with groundwater pollution, 95 with surface water pollution, 49 with air pollution and 69 with soil contamination.

This fact that exposures can take place through various media has significant bearing on the applicability of the typical hedonic property value equation to hazardous wastes. In the case of air or noise pollution, the environmental (levels of pollution) variable can be measured reasonably well by monitoring stations within an urban area. However, a similar monitoring system has not been developed for hazardous waste sites. Where monitoring is done to meet federal and state regulations, it generally does not include the contaminant levels in all of the media that may be routes of exposure. Also, the wide range of hazardous substances that typically constitute wastes at a particular site complicate the issue of defining a single indicator pollutant such as SO_x or particulates. For example, a hazardous waste site in Michigan was found to contain over 30 chemical compounds, 17 of which were either toxic or a known carcinogen, mutagen or teratogen. Given this measurement problem, it may not be possible to define a good measure of environmental quality near hazardous waste sites. Alternative and much cruder measures of quality, such as proximity or the existence of contaminated private wells, may be all that can be objectively measured.

B. Public Perceptions and Information

It was noted earlier that land prices reflect only those amenities that are understood or perceived by land market participants. In other words, the risks associated with hazardous waste sites will be capitalized in land values surrounding the site only if the public is aware of the existence of the site and its risks. Although public awareness certainly exists for several sites, many sites have gone undetected for years. Further, of the numerous media through which a site poses health and environmental risks, some may be noticeable and others may not. For example, certain consequences (such as odors) of air pollution from a particular site will almost surely be realized by nearby residents. On the other hand, minute but unhealthy levels of chemicals in drinking water may go unobserved. Clearly, the absence of a property value differential in the latter case could not be interpreted as zero willingness to pay.

The general point is not just of isolated interest. In fact, the environmental problems with hazardous waste sites often go unnoticed until government actions uncover the real risks. This could lead, as noted by a reviewer of an earlier draft of this section, to a rather strange effect. To the extent that government clean-up efforts reveal information on site risks that had been unknown, clean up could be associated with increased costs to home owners as the information is translated into lower property values.

The interpretation of property value impacts from hazardous waste sites may also be complicated by the timing of effects. Studies on the land price impacts of industrial or development activity reveal that land price differentials will often vary over time in distinct stages. These effects may reflect changes in the public's attitude toward the development. For example, land prices may fall at first as residents learn of the development plan and then rise as land market participants see an opportunity for speculative gains or the public becomes used to the idea.

This concern over timing of price effects may have significant bearing on hazardous waste site property value studies. One can imagine a time profile of price impacts associated with older sites. There may be no discernable price differential before a site is discovered and clean-up actions begin. At this point, property values may show a sharp decline as public awareness and fear grow. This price decline could in turn be followed by a price change back to the prediscovery period if land buyers and sellers think that the clean-up actions successfully alleviated the risks. While this three stage process is admittedly oversimplified, it does suggest that possible differences between short-run and long-run impacts should be accounted for in compensation schemes. It also suggests that the choice of time periods for property value analysis should be carefully considered.

C. The Relationship Between Distance and Property Values

If property values are in fact affected by the risks associated with hazardous waste sites, one might assume that a gradient of price effects would emerge based on the distance of the property from the site. Of course, distance alone may not be an adequate measure of risk from a given site. The direction of prevailing winds and underground movement of water in aquifers also should be considered. Nonetheless, distance alone may be a useful proxy for risk. A cross-sectional regression of property values on distance from a site, housing and neighborhood characteristics, environmental parameters not related to the site, income and other locational attributes could isolate the existence of a property value gradient.

It has already been noted that such a measure would provide only a rough measure of benefits. In addition, the site or sites selected for such an analysis and the risks associated with the site would have to be well publicized to ensure informed market participants. Finally, it is important to ensure an adequate number of observations that the site abuts or affects residental properties. This may limit the number of available cases, since many sites are located in industrial or rural areas.[1] Property values in such areas could not be expected to reflect benefits nearly as well as in residential areas; low turnover and improvements would make industrial property prices unsuitable for analysis, and unless agricultural productivity is affected, there may be no mechanism to internalize consumer effects on the price of agricultural land.

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[1] For example, of 21 proposed or current facilities studied in an EPA report, 10 were located in rural areas, 6 in urban and 5 in suburban locations. The adjacent land use for the facilities was mostly industrial (8) and agricultural (6).

It may also be possible to expand this analysis to study the variation in rent gradients between an unsafe site and a site that meets federal or state regulatory requirements. Everything else being equal, one would expect less of a depressing effect on property values at a given distance for the safe site relative to an unsafe site. For example, Figure 1 shows hypothetical rent gradients for two sites, one considered unsafe (I) and the other relatively safe (II). Prices are depressed relative to surrounding equilibrium values up to some distance A where the effect becomes indistinguishable from zero. The specific functional form for the distance effect would be established empirically. Although the difference between the curves will depend on the information available to buyers and sellers of land near the sites, the results could prove useful in answering the questions posed in the introduction of this Appendix: the value placed on remedial action to bring sites into compliance with current regulations.

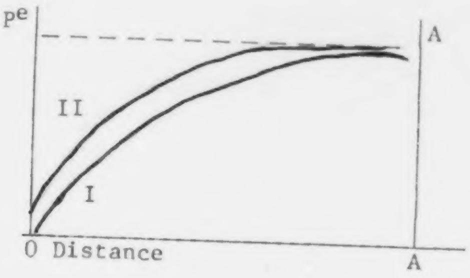

Figure 1

D. Time Series Analysis of Hazardous Waste Property Value Impacts

In the beginning of this paper the question was posed concerning the appropriate compensation for individuals exposed to disposal site risks. A time series study of property values before and after the siting of a disposal facility might be superior to a single cross-sectional equation in determining the economic damages that occur in facility siting. Under this approach, a recently established site meeting current safety standards would be chosen. One method would use a carefully specified cross-sectional equation showing the pre-siting price gradient and compare it with a post-siting gradient to show impacts at varying distances from the site. An alternative method would be to generate a price index and attribute changes in the index at the time the facility was sited to that decision. This latter approach must still confront the problem of measuring variation in effects as a function of distance from the facility.

V. SUMMARY/CONCLUSION

The principal purpose of this Appendix was to outline the major theoretical and empirical literature on property value studies. In doing so, we have focused on some of the more important uncertainties and limitations resulting from the required assumptions and data constraints that will affect application of this technique to hazardous waste sites. There are three significant conclusions. First, it appears that the hedonic approach offers a potentially useful tool for assessing the property value effects of hazardous waste sites. Second, the theoretical and empirical concerns with the hedonic approach to benefits estimation suggests strongly that the estimation of price effects may be all that is realistically possible. Third, the paucity of information of hazardous waste site characteristics limits the researchers' ability to define a quality or contamination variable for the property value equation and that a distance variable, along with perhaps dummy variables for contaminated private wells, may be the best that will be available.

Given these conclusions, the remaining sections of this report describe empirical tests of the hypothesis that hazardous waste sites have a depressing effect on nearby residential property values. The tests will follow the general design set forth below. While the model formulations focus almost entirely on price effects, they may provide useful information on the compensation questions discussed in the introduction of Appendix A. The models outlined here are not envisioned as the final word, but represent an initial attempt to determine the usefulness and applicability of property value studies for guiding hazardous waste regulatory decisions.

A. A Cross-sectional Study of a Site Known to be the Cause of Damages to Health and the Environment

The purpose of this analysis would be to establish the existence of a property value gradient based on distance from a site. To the extent the estimated equation is able to isolate a relationship between distance from the site and increased property values, it may offer a useful tool for assessing the potential damages resulting from hazardous wastes sites and for determining the appropriate locational characteristics of a site. Three caveats should be mentioned. First, no attempt will be made to translate these effects, if any, into anything more than a crude measure of lost benefits. Additional methodological research must be conducted before a better measure of benefits can be developed. Second, it will not be possible, in any formal way, to determine what type of damages (i.e., acute versus chronic health effects) are captured in the estimates. This would require survey data on the risk perceptions of participants in the land markets around a site. Third, it is possible that the effect of distance from a site will be related to distance from other disamenties. Further, the existence of contamination (say of groundwater supplies) may be unrelated to distance. In these cases, the regression results may be confused and provide misleading conclusions. Overcoming this problem requires careful site selection, data collection, and model specification.

B. A Cross-sectional/Time-series Study of a New Site

In this analysis, two cross-sectional equations would be estimated: one before a hazardous waste facility was sited and one after in an attempt to identify the effect of the facility on land values in the vicinity. This might be shown as a change in the property value gradient as a result of the site or the existence of a gradient where none had existed before. If this study is successful, it could be extended to other sites and used to determine the compensation payments needed to offset the disamenities associated with a site. Moreover, comparison of results from the two studies should help reveal information on the value of remedial action to reduce risks.

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APPENDIX B

Site Selection Criteria and Application

by

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Preface

Appendix B reviews the site selection process and describes the criteria employed for choosing sites. The focus is on those criteria which were not described in detail in Chapter III in the main body of the report. Also described are the sites which were ultimately chosen for the purpose of this study, as well as some of those which were not.

I. CRITERIA FOR INITIAL SITE SELECTION

A. Introduction

Two sets of criteria were employed in the initial site selection. The first set pertains to potential sample size and the existence of a continuous development around a site for use as a control. The fulfillment of these criteria is considered essential to an empirical investigation of hazardous waste sites. The second set of criteria is concerned with the different types of problems associated with hazardous waste sites, the extent to which these problems have been ameliorated and difficulties associated with measuring the affects of hazardous waste sites on property values. Non-fulfillment of the second set of criteria may affect empirical measurement, but does not necessarily preclude sites from consideration.

B. Sample Size

It is necessary to obtain a sufficient number of observations to study the effects of a hazardous waste site. The size of a potential sample may be predicted by the size of the population or the number of homes in the vicinity of the site and the duration of public concern. A minimum of 1,000 homes or 4,000 people as well as a two year period of public concern was considered necessary to generate a sufficient number of housing sales samples.

The necessary degree of concern is difficult to measure; however, a number of local indicators are available. Maybe the most important indicators are the number of complaints received by the local health department and the manner in which these complaints are presented. When residents present their concerns to public officials in a systematic fashion, they are presumed to be somewhat knowledgeable about the extent of the damage and its implications. The absence of an organized protest group does not necessarily imply ignorance and does not automatically disqualify a site from consideration. It does suggest, however, that more weight should be given to the other selection criteria.

Another indicator of widespread public concern with the hazardous waste site is when area residents associate health impairments they experience to the hazardous waste site in their vicinity. These health impairments may be documented by local health departments or other public agencies, or they may be undocumented and based on neighborhood consensus. While documented health effects are of major concern to residents, undocumented effects cannot be ignored.

Where there is groundwater contamination, one additional potential indicator of public concern is the number of households who resort to using bottled water as reported by the health department. The use of bottled water as an alternative may be due to bad tasting water or "rotten egg" odors perceived by residents to be associated with the hazardous waste site.

Once it is established that residents are concerned about a site, it is necessary to determine the duration of their concern. Two years are generally regarded as sufficient. However, this number will vary with population density and the velocity in the housing market. Note that for initial site selection only minimal information on public concern is required (i.e., year that awareness began).

C. Control

In the absence of an ideal control area, a residential gradient that extends for at least a couple of miles from the site is also a necessary characteristic in the choice of a study site. The gradient is used as a control for comparing the impact of the hazardous waste site on property values at different distances.

A site is only selected for further investigation if it meets this first set of criteria.

D. Type of Contamination

There are esentially two major types of contamination. The first, which for a number of years has illicited widespread concern, is air pollution. This manifests itself in the form of noxious fumes and wind blown particles from fire and/or explosion. The second is groundwater contamination, the focus of this study.

Potential damages from hazardous waste include: ground and surface water contamination, air pollution and fire and explosion hazards. Since these hazards may impact on property values differently, efforts were made to select a representative sample of the damages (scenarios).

The impact on property values of health threatening groundwater contamination is likely to depend on the availability of alternative potable water supplies. Three alternatives are considered:

- No municipal water is available to residents with contaminated wells. This may occur when there is no municipal water nearby or the hookup costs are prohibitive. Residents may be able to drill their own contaminated wells deeper to an uncontaminated aquifer, but again the cost may be prohibitive. (Additionally, deeper drillng may not be allowed for fear it will contaminate the lower aquifer.)
- Municipal water is available to homes with contaminated well water. The availability of municipal water is likely to

dampen the impact that groundwater contamination has on property values. This impact is likely to be further reduced if there is a short lag time between the discovery of contaminated wells and attachment to municipal water.

- Groundwater contamination, while widespread, poses no threat to resident's potable water because all homes are attatched to a safe supply of municipal drinking water. Hazardous waste sites with this scenario provide useful information on the non-drinking water effects of groundwater contamination.

Since a necessary requirement is that a large community be aware of the hazardous waste, sites responsible for surface water contamination only have been excluded. While the environmental impact of surface water is considerable, the measurable impact on property values is likely to be confined to those few properties in the immediate vicinity of the spill.

E. Remedial Action

The degree and speed of remedial action will most likely influence residents' perception of the health hazards and may, therefore, affect the likely property value impacts.[1] If clean up begins soon after the contamination is discovered and this clean up is anticipated to be thorough, then the impact on property values may be minimized. For example, existing home owners who would not consider selling their houses, were it not for contamination, may initially refrain from selling their homes because of anticipated, rapid remedial actions.

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[1] The options available to public officials range from immediate clean up (politically popular, but financially difficult) to superficial investigation (politically unpopular, but often financially necessary).

It stands to reason that larger property value impacts are anticipated, when the clean-up efforts are incomplete.

A hazardous waste site where remedial action was rapid and complete would, therefore. lack the after effect necessary for a study of this nature. Throughout our investigation, we encountered no site with remedial action of the extent that would warrant preclusion solely on that basis.

Speculators, for other reasons, may withhold real estate from the market if they suspect that remedial action will effectively increase land values above their pre-contamination levels. This could occur where extensive clean up removed other environmental disamenties that were previously depressing property values. In such a case the site was rejected since it was believed that meaningful evaluation of the changes between the pre- and post-contamination periods was not possible.

F. Industrial Interference

Nearby industral plants, landfills, and other hazardous waste sites tend to share common nuisance characteristics with a study site, thereby making it diffficult to isolate their individual impacts on property values. These sites were not considered optimal for the purpose of this study.

II. MODEL HAZARDOUS WASTE PROCESSING FACILITIES

A. Criteria for Initial Model Site Selection

One possible method for estimating the benefits realized from conformance to existing regulations would be to calculate the difference in property value effects between a site which is in conformance with existing regulations (model site) and one that is not. Preliminary investigations were undertaken to identify such "model" sites.

The ones which were identified (Table 1) did not, however, conform to the other standard requirements of site selection, i.e., adequate sample size, residential gradient and minimal interference from industrial plants, landfills and hazardous waste dumps. As a result, the method for estimating benefits was rendered ineffective.

B. Model Site Search Sources

Six potential model hazardous waste processing facilities were suggested by the U.S. Environmental Protection Agency.

A number of model sites were also suggested by Robert Pojasek who is an economist with Weston, Inc. Currently, he is working on a contract with the Ontario Waste Management Authority to develop a government-run waste management program. As a result, he is extremely knowledgeable about model hazardous waste processing facilities.

TABLE 1: MODEL SITES

UNUSED, BUT RESEARCHED MODEL SITES	POTENTIAL SAMPLE SIZE (In Homes Or Population)	WATER SUPPLIES	EXTENT OF CONTAMINATION	PUBLIC AWARENESS AND CONCERN	COMMENTS
I.V. Conversions Marcus Hook, PA	9,880 people (3573 homes) w/in 1 mi. 40,117 people (14,906 homes) w/in 3 mi. Highly industrial.	100% municipal water.	No documented groundwater contamination.	Operations began Jan. 1980. Public concern is very limited.	Nearby waste treatment facility has had odor problems.
Envio-Safe Services 1) Grandview, ID 2) Bruneau, ID	Open range land, sparsely populated.	100% private wells.	No documented groundwater contamination.	Grandview site began operating in 1973 and Bruneau site began 1980. Sporadic public protest.	Area residents don't like the fact that most chemicals are from out of state.
Chemical Waste Management Emmelle, AL	Sparsely populated <10 homes w/in 1 mile <500 people w/in 5 mi.	Private wells & Municipal water.	No documented groundwater contamination. Some odor problems.	Operations began in August 1977. Most complaints center on transportation of waste through community.	
U.S. Ecology Sheffield, IL	Sparsely populated 20 homes w/in 1 mi 500 people w/in 3-5 miles.		No documented groundwater contamination. Surface water contaminmation has resulted in a minor fish kill.	Opened in 1967 for radioactive wastes & 1974 for chemical wastes. Organized public protest.	
IT Corporation Martinez, CA	1,800 people w/in 1 m. 50,000 people w/in 3 mi. Highly industrial.	100% municipal water.	Groundwater contamination is of minor concern because high saline content makes it unpotable.	Operations began in 1951. Numerous complaints about foul ordors. Problem corrected in 1980.	Two landfills located nearby. It is difficult for health officials to determine origin of some complaints.
SCA Braintree, MA	10,000 people w/in 1 mi. 60,000 people w/in 3 mi. Highly industrial.	100% municipal water.	Air pollution (fire).	Operations began around 1974, but residents were unaware of the site until a fire in 1978. Major public protest right after the fire but it did not last long.	

III. PRELIMINARY FIELD TRIP

The waste dump in Pleasant Plains, Dover Township, New Jersey, was selected for a site visit and preliminary investigation into the effects of hazardous waste sites on housing values. This task was undertaken at a potential study site in order to:

- ascertain the feasibility of such a cross-sectional study;
- identify some of the problems likely to be incurred in the availability and collection of housing data, and more informal information gathering; and
- to determine in a general fashion what the response to the potential hazard is likely to have on housing values.

A more specific purpose was to ascertain the problems involved in undertaking an analysis of the immediate, as well as the long-term, impacts of hazardous waste.

IV. SITE VISITS AND FINAL SCREENINGS

In order to conduct final screenings and where possible collect property value data, five of the most promising sites were visited. These are:

- Lehigh Electric and Engineering Company and Iacavazzi Landfill, Old Forge, Pennsylvania (one site);
- Lipari Landfill, Pitman, New Jersey;
- Chemical Control, Elizabeth, New Jersey;
- Pleasant Plains Dump Site, Pleasant Plains, New Jersey and the
- Andover Sites, Andover, Minnesota.

Sites were selected on the basis of the criteria outlined in Section I of this Appendix where population or number of homes near each site and the duration of public awareness of the contamination were considered sufficient to generate a significant number of house sales. According to local indicators, e.g., citizens' complaints to the health department, chemical contamination was severe enough to involve a large percentage of the community. Lastly, each site offered one of the different contamination scenarios: groundwater contamination with and without available municipal water. Table 2 summarizes this background information for each site.

Though five sites were visited, property data were collected only for the sites in Pleasant Plains, Andover and Elizabeth. Housing data for the three remaining sites were either inadequate or inaccessible. Each site visit is discussed below.

TABLE 2: SITES SELECTED FOR FINAL SCREENINGS AND VISITS

SITES	POPULATION	TYPE OF CONTAMINATION; ALL ARE HAZARDOUS WASTES	DEGREE OF CONTAMINATION	PUBLIC AWARENESS	CONTAINMENT AND REMEDY PLANS
Lehigh Electric & Engineering Co.* Old Forge, PA	500 homes w/in 1/4 m. 2,000-3,000 homes w/in 1 m. Suburban.	Groundwater and wind blown PCBs.	PCB dust is spread throughout the community by wind, car tires and people walking through the site. All use city water.	Complaints lodged by well-organized community groups. Some area residents have elevated levels of PCB in their blood. Facility began operating in 1920's; public became aware May, 1981. Closed March 1981.	The site has been "securely" fenced." EPA is investigating for remedial action.
Iacavazzi Landfill,* Old Forge, PA	300-500 homes w/in 1/4 m. Community of 10-20,000 nearby. Suburban.	Noxious fumes, groundwater.	Possible ground water cont. Noxious fumes. Almost all residents use municipal water.	Complaints lodged by organized community groups. Public concern began in late 1979. Some residents use bottled water.	Unknown.
Lipari Landfill Pitman, NJ	800-900 people w/in 1/4 m. 10,000 people w/in 1 m. Surburban.	Groundwater, Surface Water, Air Pollution.	Groundwater cont. Has spread from the 7 acre landfill to an additional 9 acres. Almost all residents use municipal H20.	Numerous property tax appeals. Community is concerned but no known organized groups involved. Public awareness began in early 1970s.	EPA is investigating for remedial action.
Chemical Control, Elizabeth, NJ	100,000 w/in 1/4 mi. continous pop. Urban/industrial.	Groundwater and air pollution; Threat of fire and explosion.	Documented ground water and surface water cont. Major explosions and fire All use city water.	Complaints have been minimal and unorganized. No none documented or undocumented health effects. Danger was presented in 1975 but public concern did not begin until 1979, with natl' coverage of incident.	Extensive 2 1/2 year clean up program completed May have increased land values.
Hazardous Waste Dump, Pleasant Plains, NJ	5,000 residents within 1/2 m. Suburban.	Groundwater.	161 private wells closed.	Extensive coverage by local papers-Widespread awareness and concern began in 1974-Dumping took place in 1971 Extensive use of bottled water.	Residents provided w/interm water supply. Barrels + soil removed-Municipal water hook up for cont. wells.
Andover Sites, Andover, MN	300 residents w/in 1/4 mi. 13,500 w/in 2 m.	Groundwater.	Cont. of test wells & 2 private wells. Def. spreading. 50% have private wells.	Request for property assesment reevaluation. Public awareness began in 1979.	EPA is investigating for remedial action. Some barrels have been removed by owner. Hook-up to city water is prohibitively expensive.

*One site.

A. Pleasant Plains, New Jersey, Hazardous Waste Dump

Pleasant Plains, located in Dover Township, New Jersey, was one of the two sites chosen for studying the impact of hazardous waste on residential property values. Preliminary investigation suggested, and a site visit confirmed, that the Dover site met all the criteria outlined in Section I of this Appendix. The residential population and the extent and duration of concern were considered to be of the magnitude which would produce a sufficient sample of housing sales, and there was no indication that the remedial action undertaken would interfere with the study. The Dover Township Landfill, which is located 2 miles from the waste dump, could, however, be a source of interference.

A brief history and litigation settlements are given below.[2,3]

During March to December 1971, 5,000 to 6,000 barrels of chemical wastes from a Union Carbide plant in Bound Brook, New Jersey, were illegally dumped on a parcel of farm land in Pleasant Plains, Dover Township, New Jersey, and in the township landfill. The wastes included aromatic hydrocarbons, benzene, toluene, styrene, xylene, ketones, alcohols and phenolic resins.

In January 1972, the Superior Court of New Jersey ordered Union Carbide Corporation to remove and properly dispose of the hazardous wastes. By April 1972, all of the known wastes had been removed.

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[2] U.S. Congress, Senate Committee on Environment and Public Works. Six Case Studies of Compensation for Toxic Substances Pollution: Alabama, California, Michigan, Missouri, New Jersey, Texas. Serial No. 96-13, 96th Congress, 2nd Session, (Washington, D.C.: Government Printing Office, 1980), pp. 339-340.

[3] U.S. Environmental Protection Agency, Office of Solid Waste Management Programs, Final Report--Analysis of a Land Disposal Damage Incident Involving Hazardous Waste Materials, Dover Township, New Jersey, by M. Ghassemi, (Redondo Beach, CA: TRW Systems Group, May 1976), p. 37.

Groundwater contamination was first discovered in early 1974, when residents began complaining about an unusual taste and odor from their well water. Chemical analysis of the well water revealed high levels of organic compounds. Though the tests were limited in their ability to characterize the contaminants, phenol, styrene and toluene were discovered.

In September 1974, 148 wells in the contaminated area were condemned by the Dover Township Board of Health and ordered sealed at the owners' expense. Residents were provided with an interim water supply until November 1974, when the municipal water system was extended to the area.

In 1976, additional groundwater contamination was discoverd in Pleasant Plains, and in 1982, it was discovered in the nearby town of Silverton. Municipal water was extended to both of these areas.

The State of New Jersey and Pleasant Plains residents sued Union Carbide for compensation. When the case was settled, residents with contaminated wells received $1,000 each and the state received $60,000 for the costs it incurred.

1. Background

According to the Census Bureau data, the population of Pleasant Plains in 1980 was 5,600.[4] Pleasant Plains is a residential community of well kept, single family homes and is one of several housing developments which emerged during the 1970s, as part of the north/south expansion of Tom's River, (the major commercial center of Dover Township).

Relative to the pre-development period, most residences are now located in housing developments as opposed to individual tracts of land.

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[4] U.S. Department of Commerce, Bureau of the Census, 1980 Census of Population and Housing, Block Statistics Reports PHC 80-1 (Washington, D.C.: U.S. Government Printing Office, 1982).

More recently, (late 1970s) development has taken the form of individual buyers building custom-built homes. Some of these latter homes are reported to cost up to $500,000. This and other anecdotal evidence suggest that Pleasant Plains has evolved into a middle and upper class residential area.

Virtually the entire population of Pleasant Plains is located within the zone designated by the New Jersey Department of Environmental Protection (DEP) in 1974 as either contaminated (Zone 1) or questionable (Zone II). The rest of the Pleasant Plains area was concluded to be uncontaminated and was designated as Zone III. (See Map II, Appendix C.)

2. Sample Size

Early investigation suggested that, based on the size of the population and the duration and extent of residents' concern for the waste dump, a sufficient sample of housing sales was available for a property value study of Pleasant Plains. Initial estimates from the Dover Township Department of Planning placed the population within 1/2 mile from the waste site at 5,500.[5] Even though the actual population for this distance was considerably less, a substantial number of useful housing sales were available to make this a feasible study site.

Widespread awareness of the contamination episodes was ensured by local newspapers which reported extensively on the hazardous waste site and accompanying groundwater contamination. Pleasant Plains' residents initially became aware of groundwater contamination in January 1974, after 3 wells were found to be contaminated. Soon after, 140 additional wells were found to be affected resulting in the condemnation of 143 wells. Well contamination continued to be a problem with new contamination being discovered in 1976 and 1982, in Pleasant Plains and Silverton, respectively.

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[5] Comparison with the data from the Census Bureau revealed that this figure was misleading and that 5,500 is the approximate population for the entire town of Pleasant Plains.

3. Control

A residential community extends for approximately 2 miles from the waste site and serves as a control for comparing the impact of hazardous waste on properties at various distances.

4. Remedial Action

Concern for the hazards of the dump on the part of Pleasant Plains residents has changed over the years in response to the remedial action that occurred. Remedial action began in 1972, with the removal of the waste from the dump. However, during this time and prior to the discovery of the contaminated wells in 1974, few residents perceived the health hazards associated with the site.

After 1974, however, residents perceived the site in an entirely different manner and two major concerns began to surface: health hazards and impact on property values.[6]

Even though health effects could not be confirmed by the health department, chemicals in the well were known to be toxic and an alternative source of water was considered a necessary precaution.

Plans were shortly developed to extend the municipal water system to the homes with condemned wells. In the interim, residences were supplied with alternate sources of potable water, e.g., fire hydrants, National Guard water tanks. Once the homes with condemned wells were attached to municipal water, residents' concern for the health hazard seemed to fall considerably.

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[6] Op. cit., M. Ghassemi.

According to realtors[7] in the area, concerns like health effects, about property values virtually disappeared as soon as affected homes were connected to the municipal water system. They indicated that initially there was some difficulty selling the homes with contaminated wells, but this problem only lasted until municipal water became available.

It is not a foregone conclusion that the delay in sale was due to contamination, however, since it is the case that mortgages are not available for homes that lack a potable water supply.[8] So it was unknown whether prospective buyers who did not wish to see homes with contaminated wells did so because of the mortgage question or the health hazard.[9]

Renewed concerns emerged in 1976, when 13 new wells were found to be contaminated. This was short lived, however, because the affected homes were quickly attached to municipal water.

5. Interference

Some groundwater contamination may have originated from a source other than the dump, namely, the Dover Township Landfill. (See Map I, Appendix C.) By 1976, monitoring results on the contaminated wells in Pleasant Plains revealed that some of the more highly contaminated ones are located closer to the landfill than to the waste site. However, hydrologists with the New Jersey Department of Environmental Protection reported that the landfill is an unlikely source because of the direction of groundwater flow. Nothing further can be said on this facility since a complete analysis of the groundwater flow has not yet been completed.

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[7] Three realtors who serve the Pleasant Plains area were interviewed in April 1982, for their impression on the impact of the waste dump on property values. These interviews tend to confirm the impressions of the realtors interviewed for an EPA report on the Dover waste dumping incident that were conducted in May 1976.

[8] Brian Flanagan (Brian J. Flanagan Real Estate).

[9] Kay Weschler (Crossroads Realty).

B. Andover, Minnesota, Hazardous Waste Sites[10]

Preliminary investigation suggested that the hazardous waste dumps and processing facility located in Andover, Minnesota, would be an appropriate study site. Like Elizabeth and Pleasant Plains, this site met all the criteria discussed in Section I.

This site was of particular interest because it offered a unique scenario where the contamination impacted a neighborhood which is served by wells and for which there is no alternative supply of municipal water. Unlike Pleasant Plains, some difficulty was encountered with the county assessment office. Consequently, not all of the information on the property record card was available for the study.

1. Background

The Andover sites are a group of five industrial properties located on 40 acres in Andover, Minnesota, approximately 20 miles north of Minneapolis. The sites received in excess of 1,000 barrels of waste solvents, paints, inks, glues and grease between 1970 and 1973. Originally, the operators of these sites were reclaiming solvents by separation and then burying the residual sludges in unlined pits. Some solvents were disposed of by burning them in open pits. Before the contamination was discovered, this 40 acre site was considered to be only a junkyard.

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[10] Information on this site was provided in part by Gorden Starkey, Anoka County Assessment Department; Tim Yantoz, Assistant Administrator, Anoka County; Jon Christensen, Health Officer, Anoka County Health Department, Anoka County Court House, Anoka, MN; U.S. Environmental Protection Agency, Hazardous Site Control Division, Office of Emergency and Remedial Response, Andover Sites: Interim Priority List (Superfund List), October 23, 1981.

In 1973, the Minnesota Pollution Control Agency (MPCA) and Anoka County officials requested the owner/operator of the hazardous waste processing facility to cease operations and begin cleanup of the chemicals stored on the site. This request and many follow up requests were ignored.

In 1975, contamination was discovered in one of the wells located on the property. Public officials' requests for clean up continued to be ignored by the site operators. Groundwater contamination was reconfirmed in April 1980, when one well on the site and two wells on the edge of the site were found to be contaminiated with unsafe levels of arsenic, cadmium, phenols, methyl chloride, benzine (a suspected carcinogen) and toluene (a confirmed carcinogen). The EPA installed 24 monitoring wells on the hazardous waste site and confirmed the contamination of near-surface groundwater contamination by metals and organic compounds.

Test results show that a shallow aquifer of about 50 feet has been contaminated. The plume is spreading four to eight feet a year in south, southwest and northwest directions (as indicated by a water contour map) toward well populated areas. Approxiamtely 10% of the private wells in the area are connected to this shallow aquifer. It has not yet been determined if deeper aquifers are affected. EPA has recently completed testing of deeper aquifers, but these results are not yet available. The impressions of MPCA field personnel and assessors for the area are that property values have not been affected. However, it is their belief that if deep aquifers are found to be contaminated, property values will be significantly affected.

In response to these results and the continued reluctance of the owners to clean up the sites, the Anoka County Board, in December 1980, decided to begin cleaning up the sites with the intention of collecting the cost at a later date. In October 1980, the MPCA initiated litigation against the owners for failure to clean up the hazardous wastes and for the costs of remedial action.

The area is comprised generally of single family homes and is predominantly white middle class. The homes, for most part, are well kept and are situated on lots of approximately one quarter acre in residential developments.

2. Sample Size

The number of residents in the area combined with the length of their awareness was considered sufficient to provide a significant number of observations.

The Andover hazardous waste site is located in a well populated suburban area. According to the local planning department, within 1/2 mile of the site there are approximately 300 residents and within 2 miles there are approximately 13,500 residents. According to local officials, residents became seriously concerned about the site in early 1979, when the MPCA realized that the problem was more than they could handle and solicited assistance from the NEPA. It was at this point that residents began to request property re-evaluations from the tax assessor's office,[11] and locally organized citizen groups began to apply pressure to local officials.

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[11] These requests were denied.

3. Control

In terms of a control, residential development is continuous for about 4 miles in all directions from the waste site.

4. Remedial Action

Remedial action at the Andover sites has taken the form of discreet removal of several of the barrels by the property owner. However, as late as December 1981, several barrels were still on the property.

5. Interference

Approximately one mile north of the waste site is a landfill operated by a statewide waste disposal company. Preliminary investigation did not reveal the presence of hazardous waste here. Therefore, this facility, even though incorporated into the study, was viewed as a different type of environmental disamenity.[12] No large industrial areas or known waste sites exist nearby.

C. Elizabeth, New Jersey, Chemical Control[13]

Based on preliminary investigation the defunct Chemical Control hazardous waste processing and storage facility appeared to fulfill most of the criteria outlined above: a large urban residential population, well informed residents, prolonged concern and possibly non-interfering factors. Upon visiting the tax assessor's office in Elizabeth, however, it was decided to reject Chemical Control as a study site primarily due to the difficulty in obtaining the property record data.

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[12] It was recently discovered that the landfill has a pit where toxic waste was once buried. The asphalt lining is now eroding and there is a fear that this is a potentially bigger problem than the waste dump.

[13] Preliminary information on this site was provied in part by: George King, Principal Environmental Engineer, Bureau of Abandoned Sites, New Jersey Department of Environmental Protection; John Surmay, Director, Health, Welfare and Housing, City of Elizabeth, New Jersey; U.S. Environmental Protection Agency, Hazardous Site Control Division, Office of Emergency and Remedial Response, Chemical Control: Interim Priority List (Superfund List), October 23, 1981.

1. Background

The Chemical Control site is located on the outskirts of the City of Elizabeth and began operating in 1970. It is bordered on two sides by industrial plants, one side by the Arthur Kill (a river) and the other by a residential area. Within 1/4 of a mile there is a continuous residential population of approximately 100,000. Most of the residences are single family homes in fair to poor condition situated on 1/8 acre lots. A number of these homes were boarded shut. There are also some three story apartments which appear to be in poor condition; a few are burned out. The area supports a fair number of small businesses, most of which are located along a fairly active commercial strip. Bordering the residential community on two sides are numerous chemical and petro-chemical plants.

Air pollution, fire and explosion seem to be the major cause for concern. According to local officials, as early as 1971, Chemical Control was violating state and local air quality standards. Groundwater contamination has also occured, but since all area residents are attached to municipal water, this was not considered to be the major issue. (There is some reason to believe that Chemical Control may not be solely responsible for the groundwater contamination.)

2. Sample Size

The residential population and the extent and duration of their concern were considered to be of the magnitude which would produce a sufficient sample of housing sales.

Area residents did not become seriously concerned about the site until January 1979, according to John Surmay, Director of the city's Health, Welfare and Housing Department. The site was brought to their attention through the combined efforts of the City to impose stricter operating procedures on Chemical Control and the national media's focus on Love Canal. Mr. Surmay believed that a serious threat existed as early as 1975, but until 1979, complaints were infrequent.

The residents' lack of concern for the site, before 1979, seems more reasonable if the site's history is considered. Before Chemical Control began processing hazardous waste, it served as a storage facility for barrels. Therefore, in 1971, when the company began processing hazardous wastes which are frequently transferred in barrels, there was little visual change in its operations. Additionally, the chemical odors that are associated with the processing of hazardous wastes may have been hard to differentiate from the odors emitted from chemical plants that had been operating in the area for years. January 1979 was therefore accepted as the date for widespread public concern of the hazards posed by the Chemical Control site.

3. Control

Beyond one quarter mile of the site, there is a continuous, densely populated area for use as a control.

4. Remedial Action

As early as 1971, Elizabeth City health officials considered the air pollution from Chemical Control and its general operating procedure as hazardous to residents and workers near the site. The city's efforts were unsuccessful until March 1978, when the Bureau of Solid Waste

Administration of New Jersey issued an administrative order requiring Chemical Control to correct several major violations. When this failed to rectify the problem, the Superior Court of New Jersey, in February 1978, placed the site in receivership. The New Jersey Department of Environmental Protection then began clean-up operations.

As clean-up operations commenced, the severity of the situation became apparent, prompting the Mayor of Elizabeth to declare a four-week state of emergency beginning May 3, 1979. Before the clean up was completed in April 1980, a fire and a series of explosions occured at the site. Residents were forced to evacuate their homes and a number of firemen were hospitalized. Clean up continued after the fire, and, according to local assessors, the clean up has had a positive impact on land values.

5. Industrial Interference

The nearby industrial plants may have shared common nuisance characteristics with the study site thereby making it difficult to isolate their impacts on residential property values. This site posed potential problems with regard to separating the individual effects of the various disamenities.

6. Data Collection

Several factors including a large population and widespread contamination suggested that Elizabeth would have been a most interesting and potentially valuable study site. A site visit was made after which a deliberate effort was made to begin collecting the data from the assessor's office. The "before" contamination years were chosen as 1973-1975, and the "after" years were 1979-1981. Given the high population concentration, observations were limited to within 1 mile of the Chemical Control site. Two residential areas were excluded because one was being redeveloped by the city and the other area was heavily industrialized.

Unfortunately, the assessors who had previously agreed to our investigation denied us general as well as the more direct assistance needed to interpret the property record cards. Moreover, unlike the Pleasant Plains office, a photo copying machine was not available and as a result the data had to be copied by hand. (It was similar to reading a road map without a legend.)

A follow up visit to Elizabeth to gather the missing data was not considered worthwhile for a number of different reasons:

- Further investigation of the study site revealed that the housing market was dissected to reflect the ethnic diversity of the area.
- Cleanup, because it continued over a number of years, is likely to continually change the residents' perception of the danger making it difficult to assess the impact on property values. In this case, there is no real demarcation between the periods "before" and "after" contamination.
- Finally, there was no indication that the assessor's office would have been more cooperative with a follow up visit.

D. Lehigh Electric and Engineering Company, Iacavazzi Landfill, Old Forge, Pennsylvania[14]

Preliminary investigation suggested that the Lehigh Electric and Engineering Company and the Iacavazzi Landfill would be appropriate hazardous waste sites. These two sites, located within 1/2 mile of each other, are close enough to be considered one site. Together, they met all of the criteria outlined in Section 1: a large suburban population, area residents are well informed about the presence of hazardous wastes and the sites should have existed long enough to allow a sufficient number of house sales to occur. However, upon visiting the tax assessor's office in Scranton and surveying the property record cards, it was decided that these sites would not be appropriate for our study, because the residential areas surrounding the site generated an insufficient number of usable housing sales.

1. Background

The Lehigh Electric and Engineering Company and the Iacavazzi Landfill are located in Old Forge, Pennsylvania, southwest of Scranton. The former is an inactive hazardous waste processing facility which was operated from the mid-1920s until March 1981. The Iacavazzi Landfill, located 1/2 mile from the Lehigh facility, was designed to receive municipal waste, but was also used illegally as a dumping ground for hazardous industrial wastes. This facility operated from 1973 to 1978.

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[14] Preliminary information was provided by Dave Lamereaux, Environmental Engineer, Lackawanna County Health Department, Pennsylvania, telephone (717) 826-2109; County Board of Assessors, Pennsylvania, telephone (717) 961-6728; U.S. Environmental Protection Agency, Hazardous Site Control Division, Office of Emergency and Remedial Response, Lehigh Electric and Engineering Company: Interim Priority List (Superfund List), October 23, 1981.

The major type of contamination present at the Lehigh facility and the Iacavazzi Landfill is air pollution, though traces of groundwater contamination have been discovered. The major contaminant stored on the Lehigh site are polychlorinated-biphenyl (PCB)-laden oils that are leaking from transformers and capacitors. The soil on the site is heavily contaminated with PCB's which are spreading across the community via wind blown dust, cars and people travelling across the site. Noxious fumes from the landfill also contribute to contamination. Due to ongoing litigation, the names of the hazardous chemicals dumped at the Iacavazzi Landfill have not been released.

Groundwater contamination has occured in the area of the Lehigh facility and the Iacavazzi Landfill, but a direct link to these facilities has not been documented. However, all residents are connected to a safe supply of municipal water which would serve to mitigate the impact of groundwater contamination on property values.

2. Sample Size

The extent of public awareness and the number of residents near the sites (500 within 1/4 mile and 2,000-3,000 within 1 mile) should have been sufficient to generate more than our required number of sales. But a survey of the property record cards, in the tax assessor's office in Scranton, revealed only 24 useful sales within approximately 1/4 mile of the site over the years 1979 to 1981. Most of the sales that occured during these years were for lots without homes and were not useful to our study. Possibly contributing to the low number of sales was the severely depressed state of the housing market in this particular community for the past two years.

Area residents became concerned with the Lehigh site and Iacavazzi Landfill in May 1981 and late 1979, respectively. Public concern for the health hazards imposed by the sites is widespread. A well organized and widely supported citizens group has petitioned state and federal officials to take remedial action. Community action has been encouraged by medical tests which revealed elevated levels of PCB's in the blood of some residents.

According to an assessor in the Scranton office, a few residents have requested property re-evaluations, but they were denied. More homeowners would request re-evaluations, according to the assessor, but they are afraid that the assessed value of their homes would plummet as a result.

3. Control

Within one mile of the site, there is a continuous population of 3,000 which is the control factor.

4. Remedial Action

In the spring of 1981, remedial action began when the U.S. Environmental Protection Agency constructed a fence around the Lehigh site and posted a 24 hour guard. Plans for the removal of the PCB's and contaminated soils from this site were still being made in December 1981. A Resource Conservation and Recovery Act Section 7003 suit was filed against the Lehigh site owner/operator in April 1980. As of December 1981, no clean-up action had been taken at the Iacavazzi Landfill.

5. Interference

Located within 3 miles of these sites are two landfills. Local residents are, however, keeping a close watch on these landfills to ensure that proper operating procedures are followed. So far, no hazardous chemicals have been detected, nor do they seem to pose any immediate threat. These sites were, therefore, not relevant for our study.

As a result of an insufficient number of housing sales, the Old Forge, Pennsylvania, location was rejected as a study site.

E. Lipari Landfill, Pitman, New Jersey[15]

Initial investigation suggested that the Lipari Landfill would be an approprite study site. This site met all the criteria outlined earlier: there is a large suburban population nearby, area residents are well informed about the site and there has been a long period of public concern.

Upon visiting the Gloucester County tax Assessor's office, it was discovered that the property record cards were not accessible. Only residents had access to their own property record cards. Further, the record cards are stored in three different township offices, and each office is open for only 2 evening hours each week. (The Lipari Landfill is located in Montana Township and is adjacent to Pitman and Glassboro Townships.) As a result the Lipari Landfill was not feasible as a study site.

1. Background

The Lipari Landfill is located in Pitman, New Jersey, approximately 15 miles south of Camden. This inactive landfill was the dumping ground, from 1958 to 1971, for industrial and domestic waste, including methanol, benzene, toluene, xylene, isopropanol, butanol, bis (2-chloroethyl) ether, beryllium and mercury.

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[15] Sources: Bill Hinshillwood, Principal Sanitary Inspector, Gloucester County Health Department, NJ, telephone (609) 845-1600; Robert Dickson, Supervising Principal of Planning, Gloucester County Planning Department, NJ, telephone (609) 881-1200; U.S. Environmental Protection Agency, Hazardous Site Control Division, Office of Emergency and Remedial Response, Lipari Landfill, Interm Priority List (Superfund List), October 23, 1981.

Groundwater contamination, surface water contamination and air pollution are all problems at the Lipari Landfill. Hazardous chemicals have spread from the 7 acre landfill to an additional 9 acres. An aquifer that underlies the landfill has been contaminated, but the extent is unknown.

Like the Old Forge site, the impact of groundwater contamination on real estate is likely to be mitigated by the fact that almost all residents are connected to a safe supply of municipal water. Approximately 5% of the area residents use private wells. The residential area is characterized as suburban with modest single family homes on 1/4 acre lots.

2. Sample Size

The number of residents near the site and the length of their awareness would have likely produced a significant number of housing sales. There are 800-900 residents within 1/4 mile of the site and 10,000 within 1 mile, according to the Gloucester County Planning Department.

Residents became concerned with the site in the early 1970s. Their degree of concern was moderate, taking the form of numerous property tax appeals rather than organized protests.

3. Control

The residential area is continuous for a couple of miles from the site and would have served as a control for comparing the impact of the hazardous waste site on property values at various distances.

4. Remedial Action

Even though residents first became concerned with the site as far back as the early 1970s, remedial action at the Lipari Landfill has been minimal. The only actions to date, have been signs warning the public of the chemical dangers and the testing of groundwater. A number of remedial plans have been suggested, but none have been implemented. In March 1980, the U.S. EPA filed a Resource Conservation and Recovery Act suit against the owner/operator of the site.

5. Interference

There are no landfills or industries located near the Lipari Landfill that would have complicated a property value study.

F. Unusable Sites

Many of the investigated hazardous waste sites did not fulfill the criteria regarding sample size and were, therefore, not eligible for final screenings and visits. The second set of criteria also played a role but was less of a determining factor in eliminating sites. Table 3 lists the unusable sites and their important characteristics. The background information for some sites is incomplete. This occured when the investigation was aborted because early evidence (i.e., population size) suggested that a site was unusable.

1. Sample Size

Most of the unused hazardous waste sites are located in rural areas where the population concentration is low. As a result, the sample size, which is predicted by population, was not sufficient. Table 3, column "Potential Sample Size," reveals the number of sites with deficient sample size. Sample size was also deficient when the period of public concern was less than approximately two years which was the case with hazardous waste sites that had only recently been discovered. See the column "Public Awareness and Date of Discovery." An example of this problem is the Davis Liquid Chemical Waste Disposal Site where contamination was discovered in June 1981.

Table 3: Unusable Sites

	[	Potential Sample Size	]		
SITES	POPULATION	PUBLIC AWARENESS & DATE OF DISCOVERY	EXTENT OF CONTAMINATION & THREAT TO DRINKING WATER	TYPE OF CONTAMINAITON	CORRECTIVE MEASURES
McAdoo Associates McAdoo, PA	500 people w/in 1 mi. 3,500 people w/in 1 1/2 mi.	Public seems satisfied with clean-up progress. Intial EPA investigation: 1979	No health complaints. Most people use municipal water.	Noxiuos fumes Surface Water Fire & Explosive hazard.	Site has been fenced and wastes are being removed
Gratiate County Landfill St. Louis, MI	4-5 homes w/in 1/4 mi. 100-150 homes w/in 1 mi. 4,000 people w/in 2 miles.	Residents are concerned, but no organized protest Discovered in 1977.	No wells contaminated but some private wells are threatened 95% of residents use municipal water.	Groundwater Surface water Air pollution	Site has been capped.
Ottati & Gross Kingston Steel Drum Kingston, NH	1,000 people w/in 1 mi.	Site discovered July 1979. Active citizens' group.	Only trace chemicals found in nearby wells. No municipal water available.	Groundwater Surface water	EPA began clean up operations in Spring '81
Keefe Environmental Services Epping, NH	500-1,000 people w/in 1 mi. 2,000-3,000 people w/in 5 mi.	Site discovered 1978-1979. Area residents are concerned.	3 wells cont. Residents were only advised to boil water 90% of area wells are threatened.	Groundwater Surface water Noxious fumes	EPA is containing spread of wastes.
Western Sand and Gravel Site Burrillville, RI	2,000 poeople w/in 1 mi.	Contamination discovered in 1979. Public involvement unknown.	Three private wells have been contaminated. People using bottled water.	Groundwater	Clean up has began.
Davis Liquid Chemical Waste Disposal Site Smithfield, RI		Contamination discovered June 1981	Some private wells contaminated, but still in use.	Groundwater Surface water	Source of contamination has not been established
Lone Pine Landfill Freehold Township, NJ	8-10 homes adjacent. 100 homes w/in 1/4 mi.	Initial EPA investigation was in 1980. Organized public protest.	Private wells show contamination below safety standard. Increases are expected. No municipal water available.	Groundwater	Unknown

Table 3 (continued): Unusable Sites

	Potential Sample Size					
SITES	POPULATION	PUBLIC AWARENESS & DATE OF DISCOVERY	EXTENT OF CONTAMINATION & THREAT TO DRINKING WATER	TYPE OF CONTAMINAITON	CORRECTIVE MEASURES	COMMENTS
Taylor Road Landfill Tampa, FL	Sparsely populated Rural	Problem discovered in early 1980.	Private wells cont. 180 families given bottled water.	Groundwater Explosive gas	Monitoring wells & gas vents installed; City water offered to 90 residences.	
Pickettville Road Landfill, Jacksonville, FL	Rural area w/light industry	No public outcry; Initial EPA investigation: 1981.	One well cont. No municipal water available.	Groundwater	Monitoring wells.	
Coleman-Evans Wood Preserving Co. Whitehouse, FL	12 families in affected areas		No wells cont.	Groundwater (sole source acquifer); Surface water	Monitoring wells installed and surface run off contained.	
Broward County Solid Waste Disposal Facility, Davis, FL	50-75 residents in immediate area	Organized protest by area residents. Problem discovered in 1981.	Contamination detected in monitering wells. The plume is stable.	Groundwater (sole source acquifer)	Ongoing hydrological survey.	
Delaware Sand and Gravel, Llangollen Army Creek Landfills New Castle, DE	1,000 people w/in 1/4 mi. 10,000 w/in 1 mi.	Initial EPA investigation: 1974.	Some private wells cont. but connected to city water; 85% of area has city water.	Groundwater (2 large aquifers contaminated); Noxious fumes	Back pumping is containing plume.	
Price's Landfill Egg Harbor, NJ	24 w/in 1/4 mi. 5,000 people w/in 1 mi.	Vigorous protests by area residents. Date of discovery unknown.	All wells in immediate vicinity cont.(30 residents) City water being extended to these residents. All other residents use city water. Claims of ill health.	Groundwater	Unknown	Great deal of speculative land investment due to the close proximity of Atlantic City
Sea Coast Niagara Falls, NY	50 homes & trailer pk. of 200 homes w/in 1/4 mi.	Moderate public protest. Date of discovery unknown.	Residents claim ill health effects.	Noxious Fumes	Unknown	Residential development continues.
SCA Porter, NY	25 homes w/in 1/2 mi. 2,000 people w/in 1 1/2 mi.	Moderate public protest. Date of discovery unknown.	Many complaints about noxious fumes Ill health effects claims. No documented contamination of private wells, but many people use bottled water.	Noxious Fumes Groundwater	Unknown	Municipal water was recently found to be highly cont.

Table 3 (continued): Unusable Sites

Potential Sample Size

SITES	POPULATION	PUBLIC AWARENESS & DATE OF DISCOVERY	EXTENT OF CONTAMINATION & THREAT TO DRINKING WATER	TYPE OF CONTAMINATION	CORRECTIVE MEASURES	COMMENTS
ABM-Wade Chester, PA	Densely populated; highly industrialized.	Active citizen's group. Initial EPA investigation: 1979. Extent of ground water cont. is unknown.	Undocumented health effects. All residents use municipal water.	Groundwater Surface water Noxious fumes	1/2 of the wastes removed.	Many of the row houses are unoccupied
Sylvester's Nashua, NH	2,000 people w/in 1 mi. 20-25,000 w/in 5 mi.	Contamination discovered in 1979. Limited public protest.	Several wells threatened. These homes converted to municipal water supplies. No wells have actually been contaminated.	Groundwater Surface water Noxious fumes	Extensive clean-up operations	Waste dump has discouraged development.
Kopper Gas & Coke Plant St. Paul, MN	Densely populated (residential)	The toxic wastes were identified in 1979, but complaints about the plant began long ago. No ill health effects documented.	Wells up to 1 mi. from site contaminated; all residents use municipal water.	Groundwater	1/2 of the wastes removed. Major efforts to contain plume.	It may be difficult to differentiate between the affects of plant operations & hazardous wastes
Chem-Dyne Corp. Hamilton, OH	400-500 people w/in 1/4 mi. 65,000 people w/in 6-8 mi.	Complaints began around 1974. Since cleanup began in 1979 complaints have decreased. Small area impacted by fumes.	Most complaints concern fumes. A standby municipal well is threatened. All residents use municipal water.	Groundwater Surface water Noxious fumes	1/2 of the wastes removed.	No wells contaminated
Love Canal Niagara Falls, NY	Residential	Extensive protest at both the local and national level.	Numerous homes abandoned or sold to government agencies. Health damage has been documented	Groundwater Surface water Noxious fumes	Extensive clean-up operations	A number of nearby wastes dumps makes it difficult to differentiate the impact of the Love Canal on property values.
////////////////////	//////////////////	////////////////////	////////////////////	/////////////		
Ellisville Area Sites, near Ellisville, MO	Large residential area nearby.	Very few citizen complaints. Problem discovered July 1980	10 shallow wells contaminated.	Groundwater Surface water	CORRECTIVE MEASURES Removal of drums began in 1980.	

Hazardous waste sites were also rejected when they illicited little or no concern from area residents. As mentioned above, concern is determined, in part, by the number of complaints. Lack of complaints was generally an indication of minimal contamination and/or sparse population, as occurred at the Pickett Road Landfill. However, at the heavily populated Ellisville Area sites, the rapid removal of the contaminents probably contributed to the low number of complaints.

2. Remedial Action

Remedial action, if complete, could shorten the period of concern below the designated two years. At the Delaware Sand and Gravel Landfill and the Llangollen Army Creek Landfill, a number of private wells were contaminated, but the residents were quickly attached to the municipal water systems. In addition, back-pumping wells were dug on the landfills to contain the contamination plume. Early remedial action, along with other factors, rendered this site ineffectual.

3. Interference

The Koppers Gas and Coke Plant and the Love Canal hazardous waste sites were rejected because of their proximity to industrial plants, landfills and/or other hazardous waste sites. The latter facilities share similar characteristics with the potential study sites, i.e., they are also sources of pollution, making it difficult to differentiate the individual impacts on property values.

Hazardous Waste Site Search Sources

The initial list of potential hazardous waste study sites was developed from the following sources:[16]

1. Top-Priority Superfund Sites EPA: The Superfund list contains the location and a brief description of EPA's top-priority hazardous waste sites. Originally the list was comprised of 282 sites, but was reduced by EPA to represent the 114 sites that posed the greatest threat to human health.

2. Six Case Studies of Compensation for Toxic Substances Pollution U.S. Senate Committee on Environment and Public Works: This report analyzes the compensation to victims of six toxic pollution incidents. Potential study sites were selected from this report on the basis of the background information provided on each incident.

3. Undocumented Sites Local officials associated with the sites, from the first two sources, were solicited for additional sites in their area. The recommended sites were then added to the list of potential hazardous waste study sites.

4. The following reports were also reviewed, but they did not provide any additional sites:

   - EPA, Remedial Actions at Hazardous Waste Sites, Survey and Case Studies.
   - EPA, Damages and Threats Caused by Hazardous Material Sites.

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[16] See References at the end of Appendix B.

References

U.S. Congress, Senate Committee on Environment and Public Works. *Six Case Studies of Compensation for Toxic Substances Pollution: Alabama, California, Michigan, Missouri, New Jersey, Texas*. Serial No. 96-13, 96th Congress, 2nd Session, (Washington, D.C.: Government Printing Office, 1980).

U.S. Environmental Protection Agency, *Damages and Threats Caused by Hazardous Materials Sites*, EPA-430-9-80-004, (Washington, D.C.: U.S. EPA, May 1980).

______________________________, Hazardous Site Control Division, Office of Emergency and Remedial Response, *Interim Priority List (Superfund List)*, (Washington, D.C.: October 23, 1981).

______________________________, Oil and Special Materials Control Division, *Remedial Actions at Hazardous Waste Sites, Survey and Case Studies*, EPA-430-0-81-0059, by N. Neely, D. Gillespie, F. Schauf and J. Walsh (Washington, D.C.: U.S. EPA, January 1981).

APPENDIX C

Results

by

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Preface

Appendix C reports the findings of the empirical investigations, which up to this point have only been briefly described. Details regarding the steps undertaken to formulate the most appropriate and statistically significant model, in addition to all the statistical results, are presented here.

APPENDIX C

RESULTS

The results of the empirical findings for both Pleasant Plains samples and the Andover sample are presented in detail in this Appendix. All of the relevant steps are presented in Tables 1-27 for the Pleasant Plains samples and in Tables 28-37 for the Andover sample.

A. Pleasant Plains

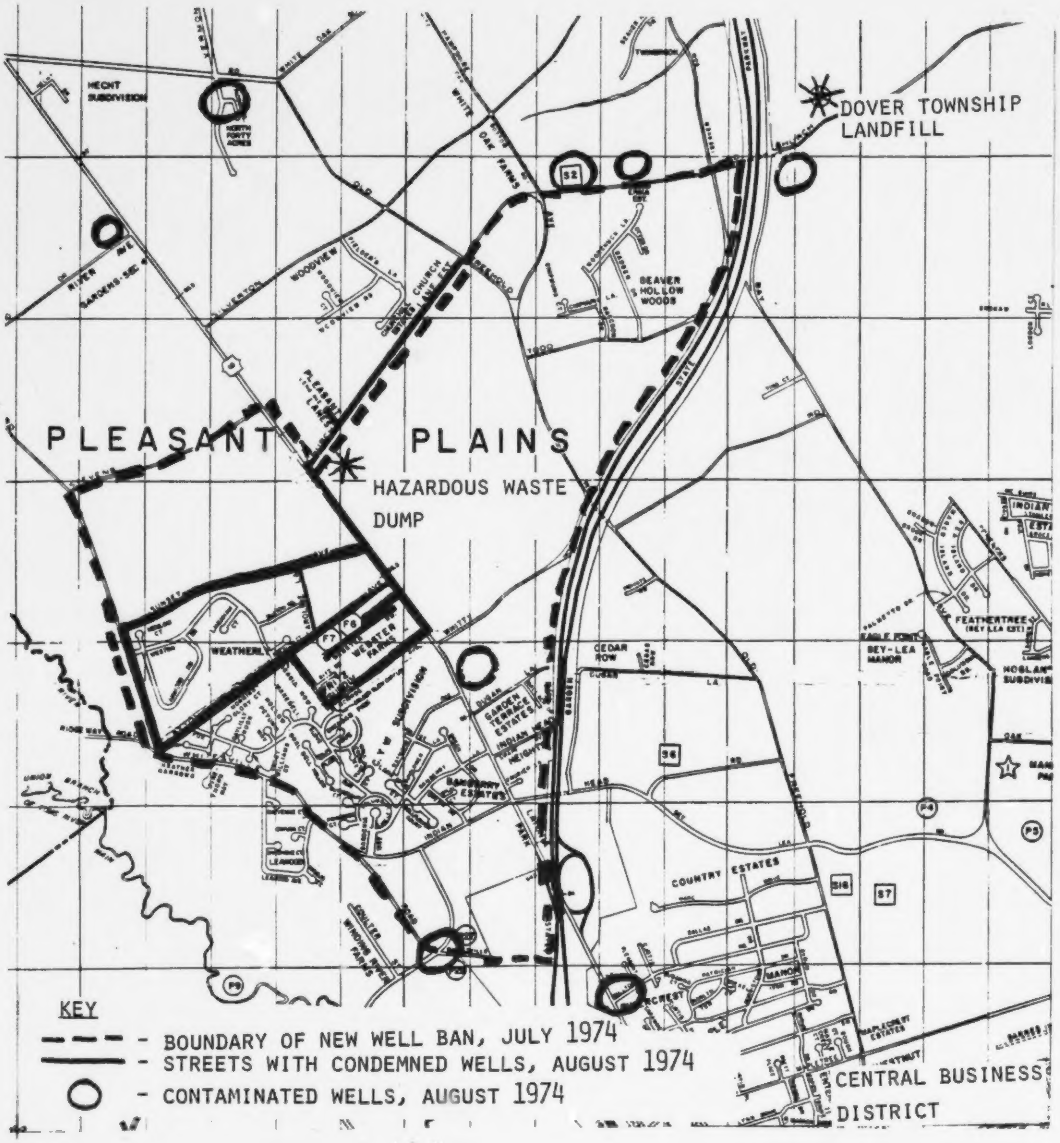
The hazardous waste dump is located in the central part of Pleasant Plains at the intersection of Church Road and Route 9 (see Map 1). Only a few scattered residences surround the dump. However, farther away from the dump the area is more populous and about one-half mile away there is a large residential development with an approximate population of 5,000.

The Pleasant Plains model was specified to include several housing characteristics, area specific information and some socioeconomic data which were thought to be important determinants of housing price. The model was chosen with regard to the existing literature, consultations with local realtors and the tax assessor's office, field trips to Pleasant Plains and prior knowledge and understanding of the housing market.

The model was formulated both to provide a good description of the housing market and to provide evidence on the effects of the waste site. Two criteria were used together to generate the best descriptive model. On the one hand, an attempt was made to generate the most statistically significant model by initially using the stepwise inclusion technique to maximize the $\overline{R}^2$, thereby excluding those variables which were below the critical level of significance. (The results of the stepwise equations

Map I

Map of the Pleasant Plains Study Area


DOVER TOWNSHIP LANDFILL
HECHT SUBDIVISION
NORTH FORTY ACRES
BEAVER HOLLOW WOODS
PLEASANT PLAINS
HAZARDOUS WASTE DUMP
WEATHERLY
WEBSTER FARMS
CEDAR ROW
GARDEN TERRACE ESTATES
INDIAN HEIGHTS
FEATHERTREE
SEY-LEA MANOR
COUNTRY ESTATES
CENTRAL BUSINESS DISTRICT
KEY
- BOUNDARY OF NEW WELL BAN, JULY 1974
- STREETS WITH CONDEMNED WELLS, AUGUST 1974
- CONTAMINATED WELLS, AUGUST 1974

SOURCES:

PATRICIA HANLON, "NEW WILLS BANNED IN POLLUTED AREA," DAILY OBSERVER, 18 JULY 1974

U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF SOLID WASTE MANAGEMENT PROGRAMS, FINAL REPORT - ANALYSIS OF A LAND DISPOSAL INCIDENT INVOLVING HAZARDOUS WASTE MATERIALS DOVER TOWNSHIP, NEW JERSEY, BY M. GHASSEMI (REDONDO BEACH, CA.: TRW SYSTEMS GROUP, MAY 1976), P.26

PATRICIA HANLON, "POLLUTED WATER AREA GROWING," DAILY OBSERVER, 6 AUGUST 1974.

"STATE CONFIRMS 2 POLLUTION TESTS," DAILY OBSERVER, 9 AUGUST 1974.

"MEETING SLATED ON WATER LINE," DAILY OBSERVER, 16 AUGUST 1974.

are presented in Tables 4 to 6.) On the other hand, attention was paid to the problem of multi-collinearity and toward specifying the model in the theoretically most appropriate way. For example, since house area in square feet was statistically the most significant of the variables that capture house area (which includes bathrooms, rooms, bedrooms, attic and basement), bedrooms and rooms were thereafter excluded because they were considered to be alternative measures of house size and also because they were below the critcal F value.

The first regression, the results of which are presented in Table 1, is a simple linear specification with all the relevant variables included. In this model, distance from the dump expressed as a linear term was significant with the correct sign and, for the most part, all the independent variables had the expected signs except lot size for which the coefficient was statistically insignificant.

Multi-collinearity was found on inspection to be particularly a problem with respect to lot size, house density and outbuildings, the latter, which were measured in square feet in addition to house density, were highly correlated with lot size. This is because house density and lot size are simultaneously determined. House density measures the number of houses per acre in an enumeration district which, in turn, is determined by the size of each lot. Since house density as measured was less reliable,[1] it was dropped from the equation in lieu of lot size even though the significance of the coefficient on lot size fell below the critical F.

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[1] House density is the number of housing units per acre. This means that, depending on the starting point for measuring an acre, a particular house could end up with any of a number of different values.

We were not totally satisfied with the results from the first equation and so efforts were made to improve the overall results by respecifying the model in various other forms. In general, on the basis of the stepwise process, the semi-log specification produced better results than property values entered as a linear term, both in terms of individual variables and the overall fit of the equation. The variable measuring distance to the dump was significant in both its linear and semi-log forms. However, quadratic and reciprocal transformations did not produce significant results.

Further analysis of the results was undertaken by examining the residuals. For this purpose a regression was run with all variables measuring distance from facilities omitted. It was expected that any unexplained variation in the model which was geographically concentrated could be identified and possibly explained. Upon inspection of a detailed map of the area, it was discovered that for the majority of cases the high residuals were congruous with extremely large lots. It was felt that since the zoning variable only captures the present zoning restrictions, which can be changed, these lots could likely be subdivided in the future. The zoning variable was, therefore, thought to be an inadequate measure of the potential value of these lots. Thus, all lots larger than two acres were omitted from the sample, except those which could not, for other reasons, be subdivided.[2] (See equations 7-27 for the equations generated without the large lots.) Further, the number of outbuildings was substituted for the area of outbuildings (square feet) in order to make that variable more independent of lot size.

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[2] These lots do not appear to have any physical capabilities for accommodating access roads.

Of the variables omitted after equation 6, Distance from Route 9 (DAR) was omitted because the correlation coefficient indicated some collinearity with other distance variables. For example, the value of the correlation coefficient with DAR and Distance from the Central Business District was .51 and DAR with Access to the Parkway was .68. In these cases, DAR proved to be the most statistically insignificant of two variables that are highly collinear. Hence, DAR was omitted and the more significant variables retained.

Additional changes to the model were made on the basis of further inspection. For instance, it was felt that more observations were required outside of a one and a half mile radius from the waste dump to be able to interpret the distance gradient and establish whether an equilibrium is approached. At this stage, approximately 60 more observations were added. (Tables 7 to 27 reflect the larger sample.) The changes documented above seemed to improve the results overall and, in particular, the lot size variable.

Analysis of the data from this stage was concentrated in general on the effect of the waste site and specifically on the distance variables and the demarcated zones of contamination. Two contaminated zones were identified by the New Jersey Department of Environmental Protection and designated Zone 1 and Zone 2. Zone 1 is where the capping of wells was ordered and the complete hook-up to the municipal water supply undertaken. Zone 2 represents the area where property owners were ordered to dig wells to the deeper aquifer.

For focus on the contamination, the sample of sales which occurred before the contamination episode was introduced for analysis. The two samples, one consisting of transactions which occurred before 1974 and the other of transactions after 1974, were examined for possible differences with respect to the areas "inside" the zones and the areas "outside" the zones. (See Map II.) Two subsamples, one representing the observations "inside" the combined contamination zones and the second characterizing observations "outside" the zones, were run separately using the same model for both the before and after contamination samples. The results of these are presented in Tables 7 to 10. A Chow test was used to determine whether there were significant differences, on the one hand, between sales "inside" the contaminated area and the "outside" for the period before contamination and, on the other hand, between sales "inside" and those "outside" for the post-contamination period.[3] Thus, it appears that the "contaminated" area was more significantly different from the uncontaminated area after, than before, contamination.

Because of the time differences between the "before" and "after" samples, we were unable to use the same test to determine differences for those samples.

Further investigation was undertaken to determine whether the contamination effect could be identified in any single variable in the equation other than a specific contamination variable. We were particularly interested in the sale date variable since there is reason to believe that price increases were not as strong "inside" compared with "outside" the zone because of contamination. Furthermore, there may have been a time lag before people responded to the contamination episode, in which case the trend would have been dampened, particularly in the latter years following the contamination episode. However, neither of these hypotheses was borne out by the results. Figures 1 to 4 present the sales trend for four subsamples: before "inside" and "outside" the zone and after "inside" and "outside" the zone.

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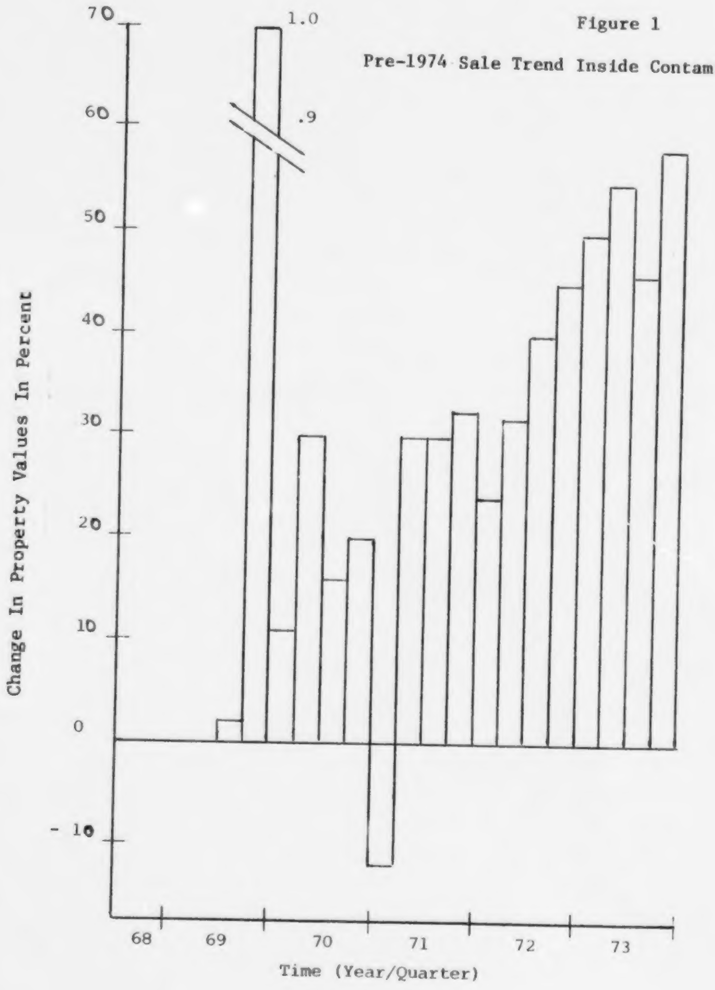
[3] The F statistic for the "after" sample was 2.13. This was above the critical F of 1.67 at the 1% level of significance. The F statistic for the "before" sample was 1.46, which is above the critical F of 1.39 for this model at the 5% significance level, but below 1.59, the critical level for the 1% significance level. In order to use the Chow test, Samples 1 (inside and outside combined) and 2 (inside and outside combined) were run with the same model (Tables 12 and 13).

The "after in" subsample, contrary to prior hypothesis, demonstrated a stronger inflation rate than the "after out" subsample. This, coupled with the fact that prices in the "before in" subsample rose more slowly than in the "before out," suggests that the area of Pleasant Plains that was contaminated had become more attractive after the contamination.

Further examination was undertaken to determine the usefulness of the contamination zones for assessing the extent of contamination. Results presented in Tables 17, 25 and 27 suggest that the zone designated by the New Jersey Department of Environmental Protection (DEP) did not necessarily represent the area of concern. Examination of the monitoring results confirms that the areas described as contaminated did not include all areas which had had positive test results. In fact, the contaminated zones denominated by DEP, in its final report of December 1974, did not take account of every monitoring result--only the ones which turned out to be consistently positive. While this may be thought to provide a more reliable picture of contamination, it may not correspond to people's perceptions of reality since they may respond equally to a single positive monitoring result.

Figure 1

Pre-1974 Sale Trend Inside Contamination Zone (Table 7)

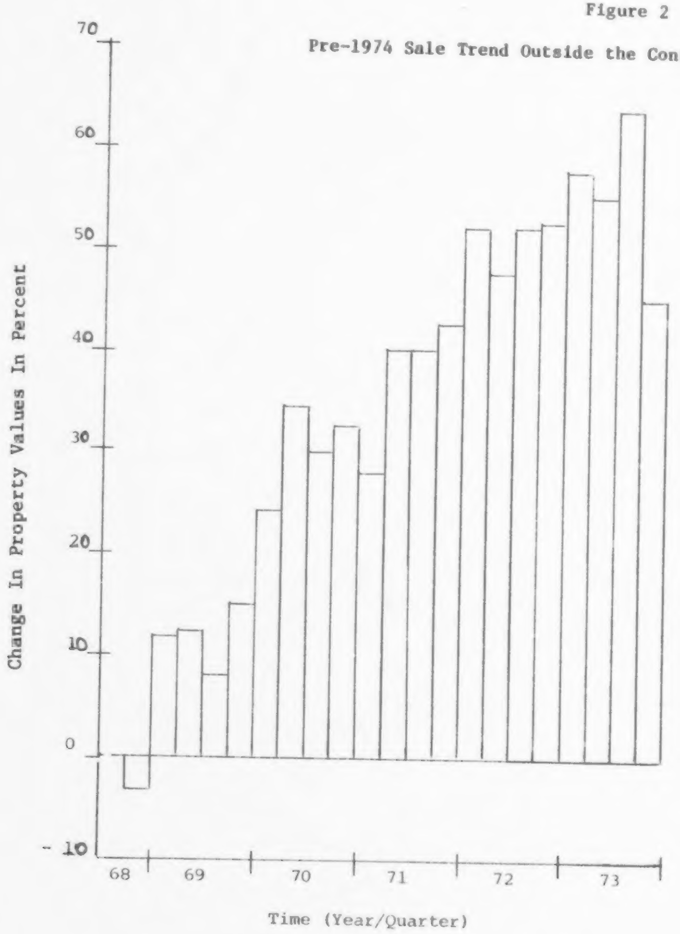


Time Yr/Qtr	Coeff.	F	Obs.
68/3	**	**	0
68/4	**	**	0
69/1	**	**	0
69/2	*	*	2
69/3	.0226	0.029	3
69/4	1.0237	3.787	1
70/1	.1093	0.481	2
70/2	.3008	2.877	1
70/3	.1568	1.531	6
70/4	.1988	2.592	12
71/1	-.1203	.668	3
71/2	.2927	5.638	12
71/3	.2967	5.374	17
71/4	.3239	6.578	19
72/1	.2412	3.087	7
72/2	.3215	6.389	12
72/3	.4038	10.795	11
73/4	.4475	12.828	6
73/1	.5050	14.560	4
73/2	.5534	18.195	8
73/3	.4589	13.854	14
73/4	.5832	21.734	6

*Ommitted Dummy
**No Observations
Obs. - Number of Observations

Figure 2

Pre-1974 Sale Trend Outside the Contamination Zone (Table 8)



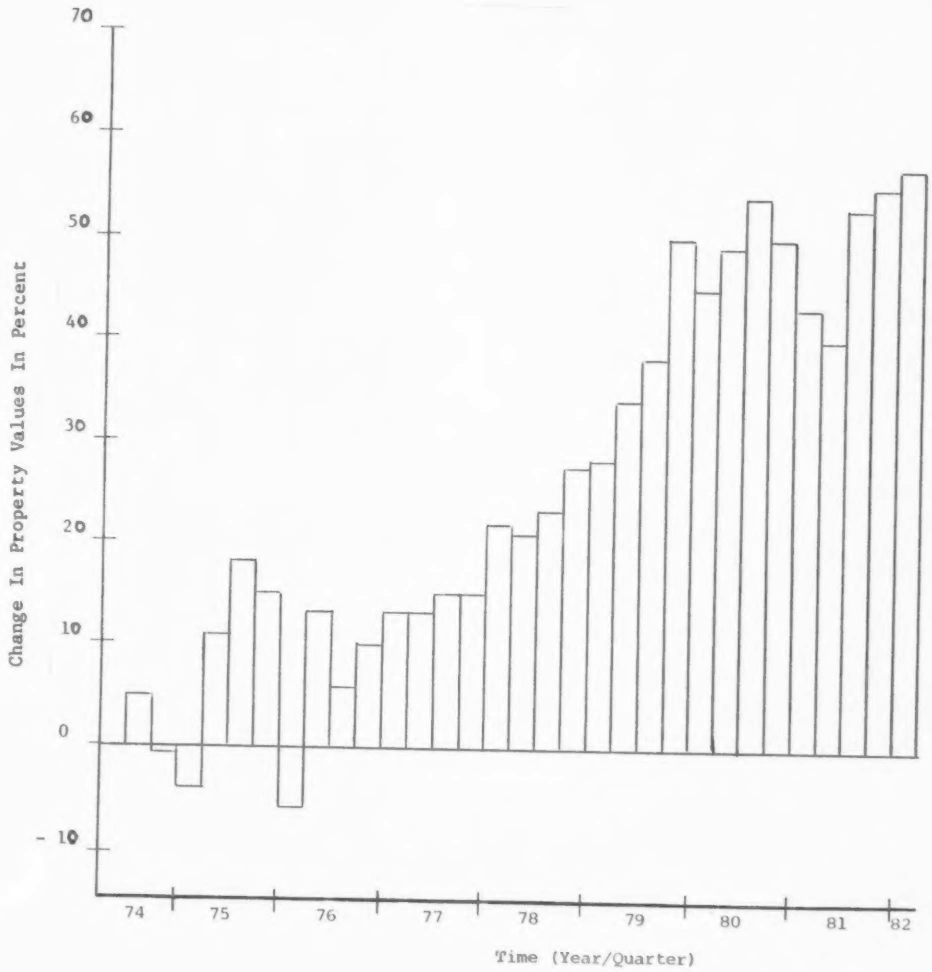
Time Yr/Qtr	Coeff.	F	Obs.
68/3	*	*	1
68/4	-.0340	.020	1
69/1	.1223	.275	1
69/2	.1236	.289	1
69/3	.0823	.149	1
69/4	.1479	.531	3
70/1	.2404	1.556	2
70/2	.3706	3.837	2
70/3	.2956	2.964	4
70/4	.3257	3.618	4
71/1	.2843	1.57	1
71/2	.4041	5.039	8
71/3	.3955	4.601	5
71/4	.4266	4.935	3
72/1	.5181	7.543	5
72/2	.4748	6.649	3
72/3	.5207	8.051	4
72/4	.5242	8.935	3
73/1	.5742	9.838	6
73/2	.5465	7.675	3
73/3	.6340	14.964	7
73/4	.4523	5.736	2

*Ommitted Dummy

Obs. - Number of Observations

Figure 3

Post 1974 Sale Trend Inside the Contamination Zone
(Table 9)

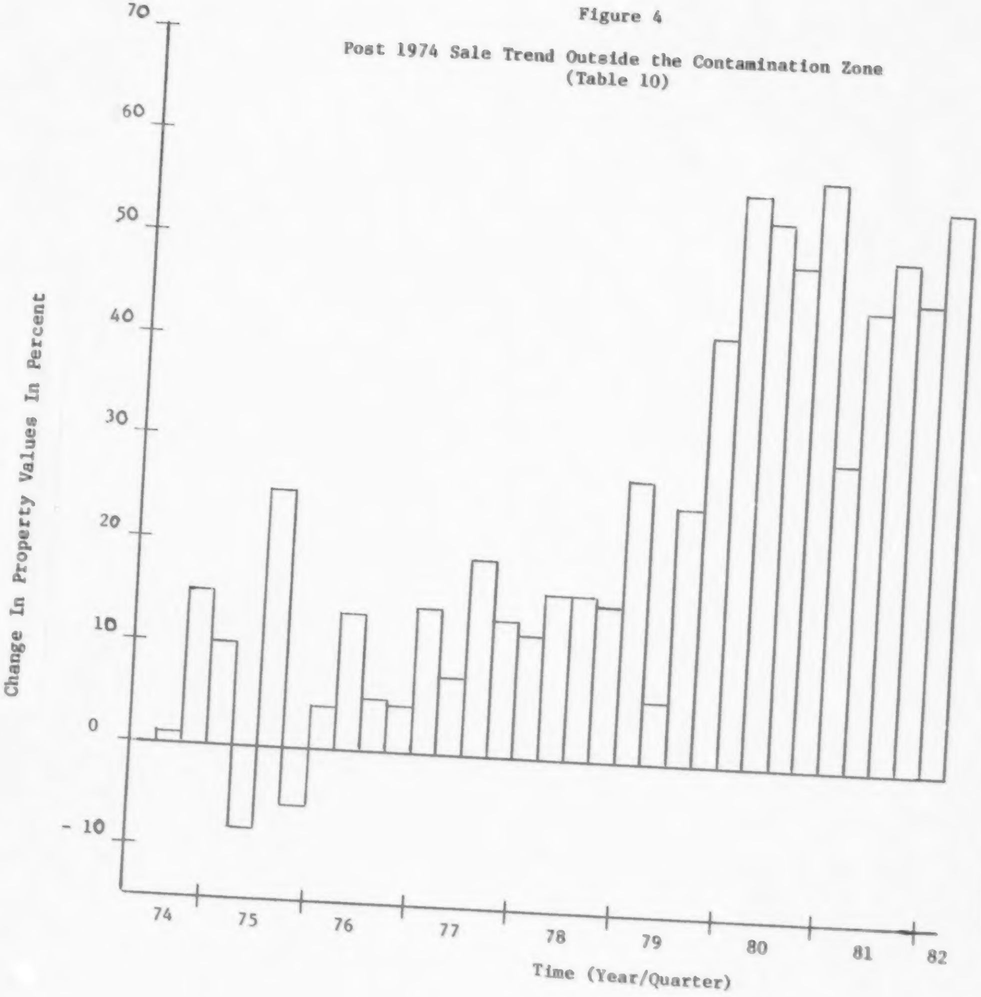


Time Yr/Qtr	Coeff.	F	Obs.
74/2	*	*	4
74/3	.0473	.348	5
74/4	-.0076	.012	8
75/1	-.0390	.203	4
75/2	.1138	1.745	3
75/3	.1823	5.944	6
75/4	.1052	1.619	5
76/1	-.0589	.513	4
76/2	.1353	2.845	5
76/3	.0624	.746	8
76/4	.0970	2.244	20
77/1	.1341	4.143	15
77/2	.1291	3.264	8
77/3	.1546	5.049	12
77/4	.1472	5.534	28
78/1	.2152	9.957	12
78/2	.2106	8.291	7
78/3	.2346	12.601	16
78/4	.2757	18.825	24
79/1	.2798	19.004	26
79/2	.3382	27.470	13
79/3	.3809	31.968	14
79/4	.5063	53.981	10
80/1	.4471	40.276	10
80/2	.4891	34.268	4
80/3	.5408	57.620	7
80/4	.5049	48.811	7
81/1	.4340	34.696	7
81/2	.4032	21.140	3
81/3	.5332	37.674	4
81/4	.5534	60.090	8
82/1	.5684	36.822	3

*Ommitted Dummy
Obs. - Number of Observations

Figure 4

Post 1974 Sale Trend Outside the Contamination Zone
(Table 10)



Time Yr/Qtr	Coeff.	F	Obs.
74/2	*	*	4
74/3	:0473	.348	5
74/4	-.0076	.012	8
75/1	-.0393	.203	4
75/2	.1138	1.745	3
75/3	.1823	5.944	6
75/4	.1052	1.619	5
76/1	-.0589	.513	4
76/2	.1353	2.845	5
76/3	.0624	.746	8
76/4	.0970	2.244	20
77/1	.1341	4.143	15
77/2	.1291	3.264	8
77/3	.1546	5.049	12
77/4	.1472	5.534	28
78/1	.2152	9.957	12
78/2	.2106	8.291	7
78/3	.2346	12.601	16
78/4	.2757	18.825	24
79/1	.2798	19.004	26
79/2	.3382	27.470	18
79/3	.3809	31.968	14
79/4	.5063	53.981	10
80/1	.4471	40.276	10
80/2	.4891	34.268	4
80/3	.5408	57.620	7
80/4	.5049	48.811	7
81/1	.4340	34.698	7
81/2	.4032	21.140	3
81/3	.5332	37.674	4
81/4	.5534	60.090	8
82/1	.5684	36.822	3

*Ommitted Dummy
Obs. - Number of Observations

In fact, the monitoring results were widely disputed by the residents of the area which throws doubt on the usefulness of the contamination zones as a proxy for contamination in our analysis.

The most fruitful approach to gauging the effect of a disamenity on residential property values was distance measured in concentric circles from the source of the disamenity. Distance variables representing quarter mile sections were constructed and substituted for the linear term. The resulting coefficients were plotted against distance and are displayed in Figure 5. At 1.75 miles from the dump, a statistically significant gradient may be observed.

A similar treatment of the distance variable (dummy variables constructed for distance from the disamenity) was used to test the "before" sample. These results may be observed in Figure 6 and equations 18, 19 and 26. However, the coefficients proved in this case not to be statistically significant. This suggests that the price gradient observed for sample 1 may be attributed to the effect of the dump.

Various functional forms were tried for the distance variable. Nonlinear transformations of the distance variable, notably the reciprocal transformation (Tables 23 and 24), were found not to be statistically significant. The double log specification[4] tried on sample 2 (Table 22) also proved not to be significant.

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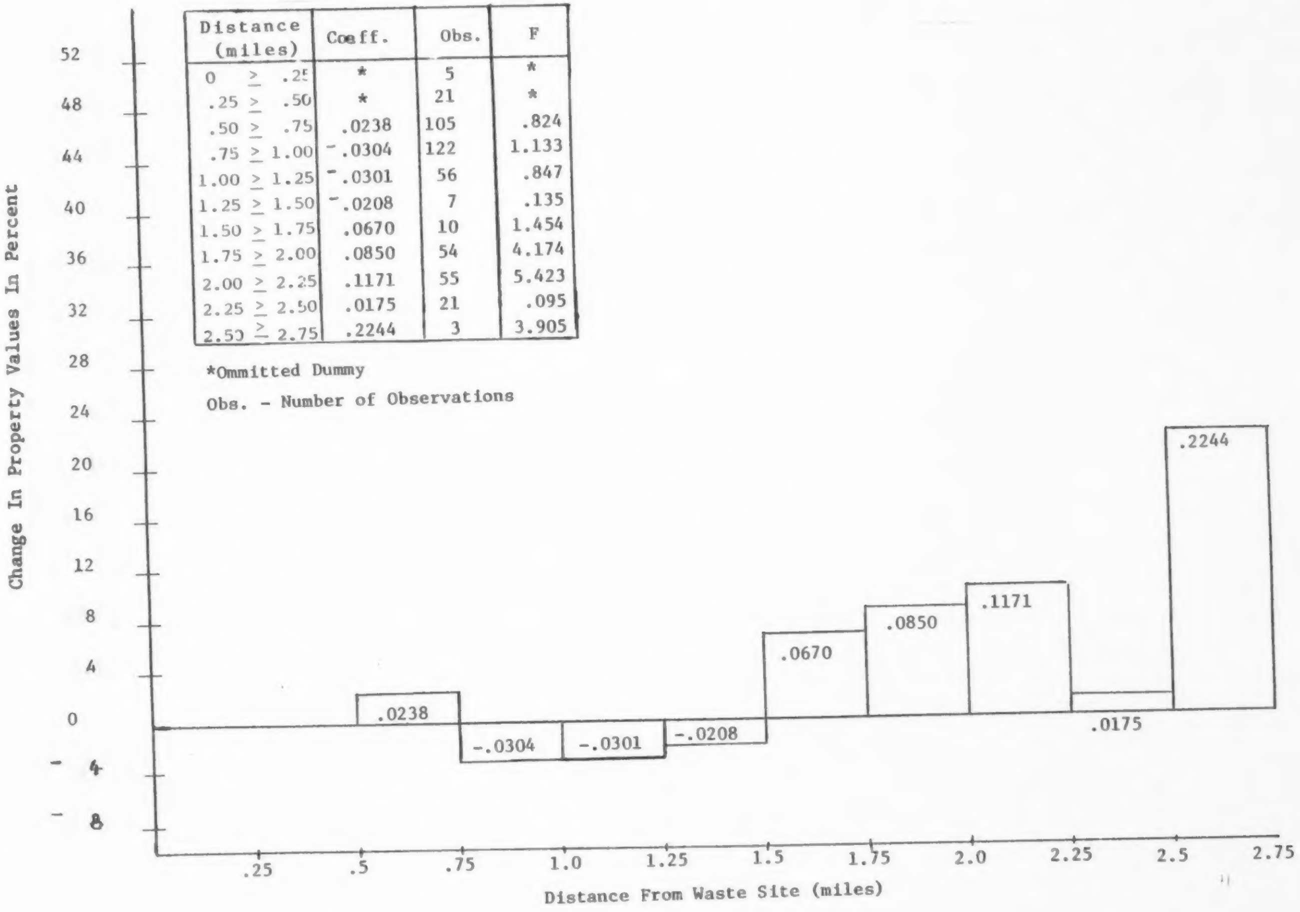
[4] Natural log of dependent, as well as some independent, variables.

Figure 5

Distance Gradient After Contamination (Table 21)



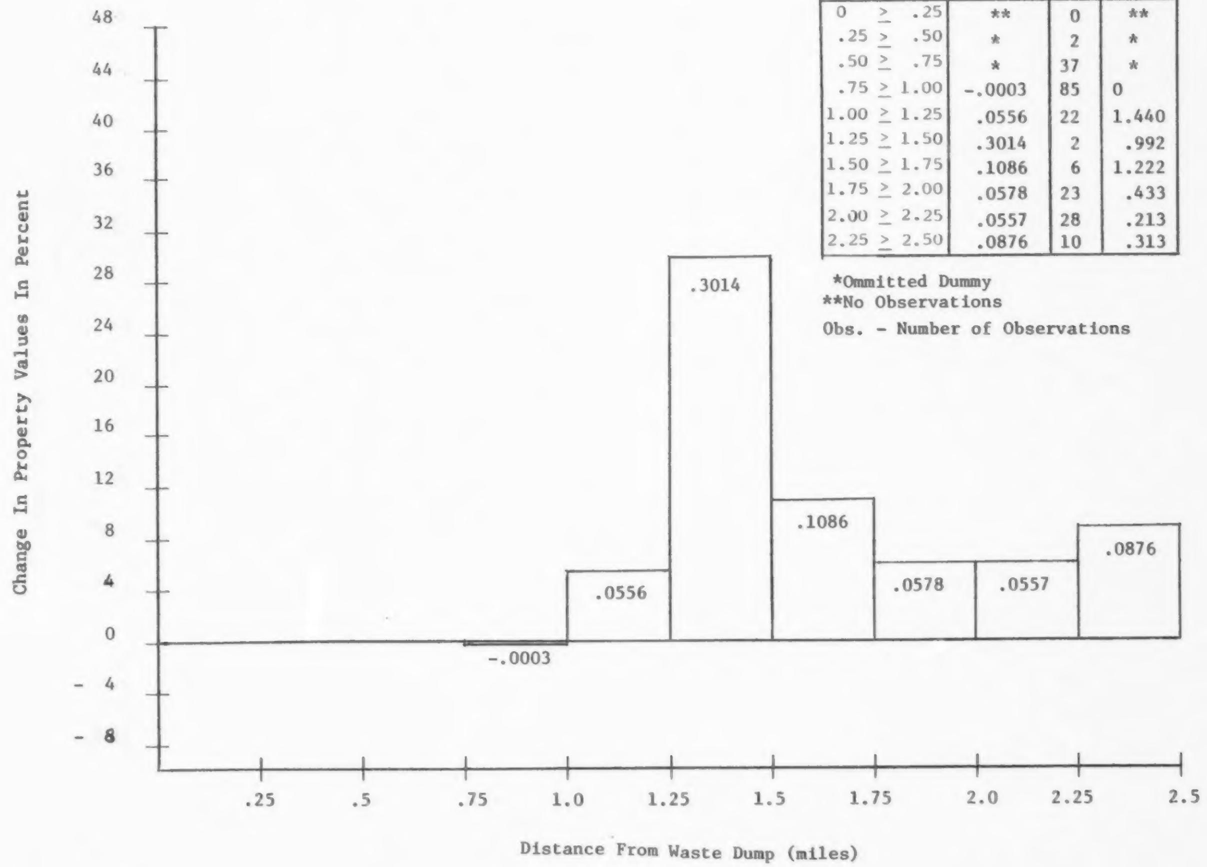
Distance (miles)	Coeff.	Obs.	F
0 ≥ .25	*	5	*
.25 ≥ .50	*	21	*
.50 ≥ .75	.0238	105	.824
.75 ≥ 1.00	-.0304	122	1.133
1.00 ≥ 1.25	-.0301	56	.847
1.25 ≥ 1.50	-.0208	7	.135
1.50 ≥ 1.75	.0670	10	1.454
1.75 ≥ 2.00	.0850	54	4.174
2.00 ≥ 2.25	.1171	55	5.423
2.25 ≥ 2.50	.0175	21	.095
2.50 ≥ 2.75	.2244	3	3.905

*Ommitted Dummy

Obs. - Number of Observations

Figure 6

Distance Gradient Before Contamination (Table 26)



Distance (miles)	Coeff.	Obs.	F
0 ≥ .25	**	0	**
.25 ≥ .50	*	2	*
.50 ≥ .75	*	37	*
.75 ≥ 1.00	-.0003	85	0
1.00 ≥ 1.25	.0556	22	1.440
1.25 ≥ 1.50	.3014	2	.992
1.50 ≥ 1.75	.1086	6	1.222
1.75 ≥ 2.00	.0578	23	.433
2.00 ≥ 2.25	.0557	28	.213
2.25 ≥ 2.50	.0876	10	.313

*Ommitted Dummy
**No Observations
Obs. - Number of Observations

TABLE I

PROPERTY VALUES REGRESSED ON THE LINEAR FORM OF DISTANCE FROM THE WASTE SITE---SAMPLE I

----------- Variables in the equation ------------------

Variable	B	Std error B	F
DLF	0.1412815D+01	6.12650	0.053
LSZ	-0.3300416D-01	0.01370	5.802
GRG	0.4323341D+01	1.22736	12.408
RMD	0.2609426D+01	2.02015	1.668
AGE	-0.1115501D+00	0.05860	3.624
COND	-0.4873281D+01	2.92535	2.775
BMT	-0.3609043D+01	1.56784	5.299
BMTC	0.3320548D-01	1.92510	0.000
RM	-0.8909539D-01	0.71087	0.016
BDR	-0.6081043D+00	1.28632	0.223
ATT	-0.8147952D+01	3.92160	4.317
AIR	-0.1443362D+01	1.33870	1.162
FPL	-0.2744556D+01	1.49989	3.348
BTR	0.2252778D+01	1.59942	1.984
MDK	-0.2733063D+01	2.55976	1.140
HARE	0.1152690D-01	0.00236	23.895
PTO	0.4474179D-03	0.00542	0.007
DTBF	0.1945149D-02	0.00079	6.065
DHS	-0.8338445D+01	8.40115	0.985
DNS	-0.3316270D+01	6.58513	0.254
DAR	-0.8259952D+01	3.87839	4.536
DCBD	0.3488857D+01	3.11354	1.256
SDA	0.2307332D+02	7.68737	9.009
SDB	0.4077006D+02	5.11102	63.631
SDC	0.2830563D+02	5.76002	24.149
SDD	0.2363904D+02	6.31430	14.016
SDE	0.2491112D+02	5.37110	21.511
SDF	0.2876241D+02	5.23662	30.168
SDG	0.2678221D+02	5.54659	23.315
SDH	0.1765246D+02	6.55028	7.263
SDI	0.2380618D+02	5.21795	20.815
SDJ	0.2719390D+02	4.94277	30.269
SDK	0.1852021D+02	4.91417	14.203
SDL	0.1972768D+02	4.85172	15.533
SDM	0.1809605D+02	4.74581	14.539
SDN	0.1383422D+02	4.73932	8.521
SDO	0.1348197D+02	4.75173	8.050
SDP	0.1226818D+02	5.29290	5.372
SDQ	0.1250453D+02	4.97329	6.322
SDR	0.1107345D+02	4.48730	6.090
SDS	0.1003911D+02	5.22486	3.692
SDT	0.9319840D+01	5.06914	3.380
SDU	0.8519971D+01	4.85395	3.081
SDV	0.8768046D+01	4.67293	3.521
SDW	0.6757826D+01	5.30761	1.621
SDX	0.6863727D+01	6.17622	1.235
SDY	0.3461658D+01	6.91917	0.250
SDZ	0.4045789D+01	6.34327	0.407
SDAA	0.6261740D+01	5.86603	1.139
SDBB	0.5928024D+01	6.81676	0.756

```
SDCC         0.3048578D+01        5.33009      0.327
SDDD         0.7736741D+01        5.47920      1.994
SDEE         0.3849221D+01        5.33155      0.521
ZNA          0.7823481D+01        8.04175      0.946
ZNB          0.1659836D+02        8.28279      4.016
ZNC          0.8866928D+01       15.77653      0.316
ZND          0.7664798D+01        8.14564      0.885
ZNE          0.4065661D+01        7.68479      0.280
ZNF          0.1751909D+01        7.99983      0.048
ZNG          0.4782830D+02       16.66690      8.235
ZNI          0.2733269D+02        9.86125      7.682
ZNJ          0.9728696D+01        9.36678      1.079
ZNK         -0.1466959D+02       14.61946      1.007
ZNL         -0.3159153D+01       15.12438      0.044
ZNM          0.8711151D+01       10.02974      0.754
ZNN          0.5742701D+02       12.46650     21.220
HDEN         0.5344125D+00        0.96091      0.309
PDEN         0.1048673D+02        6.94484      2.280
UTSS        -0.1182485D+00        5.84763      0.000
UTST         0.1403324D+01        5.87319      0.057
UTWC         0.7568578D+01       11.98054      0.399
UTWW         0.1017962D+02       11.99629      0.720
CONB         0.2086391D+02        9.45667      4.868
CONF         0.1489284D+02        7.59603      3.844
CLE         -0.1649863D+02        6.47815      5.485
CLF         -0.2037459D+02        5.27341     14.928
CLG          0.4019578D+01        4.55586      0.745
CLI          0.5359969D+02       15.83650     11.455
PLG          0.1649002D+02        8.48080      3.781
PLV          0.7931958D+01        2.82146      7.903
DWD          0.7528829D+01        3.79953      3.926
DPW          0.3694339D+01        5.90198      0.392
DAC          0.1647354D+01        7.08547      0.054
(Constant)  -0.1124978D+02


Analysis of variance     Df      Sum of squares Mean square      F
Regression               88.       193976.75400  2204.28130   19.40349
Residual                350.        39760.81040   113.60232

                    Multiple R            0.91098
                    R square              0.82989
                    Adjusted R square     0.78712
                    Standard error       10.65844
```

TABLE 2

NATURAL LOG OF PROPERTY VALUES REGRESSED ON THE RECIPROCAL FORM OF DISTANCE FROM THE WASTE SITE (1/D)---SAMPLE I

------------------ Variables in the equation ------------------

Variable	B	Std error B	F
LSZ	-0.6630251D-04	0.00021	0.099
GRG	0.5493812D-01	0.01962	7.837
RMD	0.5460910D-01	0.03195	2.922
AGE	-0.9733672D-03	0.00093	1.091
COND	-0.1960835D+00	0.04561	18.479
BMT	-0.5111098D-01	0.02478	4.255
BMTC	0.1509169D-02	0.03018	0.003
RM	-0.4334114D-02	0.01161	0.139
BDR	-0.4895672D-02	0.02037	0.058
ATT	-0.1306463D+00	0.06203	4.436
AIR	-0.3733059D-01	0.02107	3.139
FPL	-0.8195990D-01	0.02371	11.945
BTR	0.5512995D-01	0.02535	4.731
MDK	-0.5290027D-01	0.04043	1.712
HARE	0.1648665D-03	0.00004	18.037
PTO	-0.3496131D-04	0.00009	0.167
OTBF	0.2211784D-04	0.00001	3.310
DHS	-0.2449403D+00	0.12745	3.693
DNS	-0.2548452D-01	0.09755	0.068
DAR	-0.4714446D-01	0.06522	0.523
DCBD	-0.1635934D-01	0.03998	0.167
SDA	0.5507716D+00	0.12131	20.614
SDB	0.7138079D+00	0.08078	78.092
SDC	0.5981384D+00	0.09093	43.219
SDD	0.5483413D+00	0.09946	30.393
SDE	0.5348779D+00	0.08505	39.553
SDF	0.6060925D+00	0.08281	53.565
SDG	0.5964121D+00	0.08780	45.146
SDH	0.2882526D+00	0.10322	7.799
SDI	0.5304887D+00	0.08250	41.347
SDJ	0.5397698D+00	0.07817	47.677
SDK	0.4205421D+00	0.07784	29.188
SDL	0.4421705D+00	0.07676	33.182
SDM	0.3552565D+00	0.07621	21.732
SDN	0.3220181D+00	0.07476	18.555
SDO	0.3087895D+00	0.07532	15.807
SDP	0.3019393D+00	0.08374	13.001
SDQ	0.2682384D+00	0.07862	11.640
SDR	0.2533145D+00	0.07106	12.705
SDS	0.2466531D+00	0.08247	8.945
SDT	0.1929222D+00	0.08032	5.770
SDU	0.2196412D+00	0.07684	8.170
SDV	0.1954406D+00	0.07399	6.977
SDW	0.1236674D+00	0.08387	2.174
SDX	0.2427919D+00	0.09953	5.951
SDY	0.3925991D-01	0.10938	0.129
SDZ	0.2208794D+00	0.10017	4.863
SDAA	0.2189581D+00	0.09243	5.612
SDBB	0.1081496D+00	0.10754	1.011
SDCC	0.1576455D+00	0.08416	3.509

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SDDD          0.1009566D+00       0.08647       1.363
SDEE          0.1114480D+00       0.08404       1.758
ZNA          -0.4479387D-01       0.10874       0.170
ZNB           0.7382624D-01       0.11941       0.382
ZNC          -0.1084743D+00       0.23993       0.204
ZND          -0.1637993D+00       0.12016       1.858
ZNE          -0.1407481D+00       0.11255       1.564
ZNF          -0.2987539D+00       0.11923       6.279
ZNG           0.5786292D+00       0.26326       4.831
ZNI           0.2826780D+00       0.15809       3.197
ZNJ           0.1326637D-01       0.12779       0.011
ZNK          -0.5408872D+00       0.23111       5.478
ZNL          -0.1142703D+01       0.22792      25.137
ZNM          -0.6672521D-01       0.15079       0.196
ZNN           0.5954443D+00       0.17967      10.983
HDEN          0.3624283D-01       0.01453       6.219
PDEN          0.1174021D+00       0.08442       1.934
UTSS         -0.3401583D-01       0.09161       0.138
UTST          0.2185819D-01       0.09103       0.058
UTWC          0.1319040D+00       0.18802       0.492
UTWW          0.1385929D+00       0.18919       0.537
CONB          0.3225711D+00       0.14928       4.670
CONF          0.2549412D+00       0.12022       4.497
CLE          -0.6384922D+00       0.19475      10.749
CLF          -0.5977309D+00       0.18513      10.425
CLH          -0.4285504D+00       0.18700       5.252
CLG          -0.3097686D+00       0.17985       2.966
CLI          -0.2067858D+00       0.30116       0.471
PLG           0.3135382D+00       0.13291       5.565
PLV           0.1066965D+00       0.04456       5.734
DWDD          0.2643728D-02       0.02292       0.013
DLFD          0.2421795D-01       0.02546       0.905
DPW           0.1324670D+00       0.07241       3.347
DAC           0.4339326D-01       0.07146       0.369
(Constant)    0.3707435D+01


Analysis of variance      Df   Sum of squares  Mean square        F
Regression                84.        55.92320      0.66575   23.53283
Residual                 354.        10.01479      0.02829

                          Multiple R            0.92093
                          R square              0.84812
                          Adjusted R square     0.81208
                          Standard error        0.16820
```

TABLE 3

NATURAL LOG OF PROPERTY VALUES REGRESSED ON DISTANCE FROM THE WASTE SITE IN 1/4 MILE DUMMIES---SAMPLE I

----------------- Variables in the equation ------------------

Variable	B	Std error B	F
GRG	0.4572726D-01	0.01853	6.093
RMD	0.7477617D-01	0.03160	5.598
AGE	-0.6774822D-03	0.00090	0.571
COND	-0.1919982D+00	0.04340	19.571
BMT	-0.6179093D-01	0.02307	7.175
BDR	-0.1337370D-01	0.01546	0.748
ATT	-0.6884345D-01	0.05993	1.319
AIR	-0.3602167D-01	0.02046	3.101
FPL	-0.8890714D-01	0.02289	15.084
BTR	0.5627635D-01	0.02394	5.527
MDK	-0.2812608D-01	0.03834	0.538
HARE	0.1461187D-03	0.00004	17.136
DHS	-0.2084494D+00	0.12426	2.814
DCBD	0.1117762D+00	0.05229	4.570
SDA	0.5821057D+00	0.10974	28.136
SDB	0.7130704D+00	0.07802	83.536
SDC	0.5841315D+00	0.08917	42.909
SDD	0.5520202D+00	0.09448	34.135
SDE	0.4984548D+00	0.08273	36.299
SDF	0.6493353D+00	0.07945	66.791
SDG	0.5871979D+00	0.08378	49.119
SDH	0.3184602D+00	0.09941	10.263
SDI	0.5306352D+00	0.07957	44.475
SDJ	0.5370976D+00	0.07529	50.896
SDK	0.4213007D+00	0.07472	31.791
SDL	0.4416574D+00	0.07375	35.860
SDM	0.3580747D+00	0.07273	24.238
SDN	0.3292053D+00	0.07182	21.010
SDO	0.2958782D+00	0.07309	16.385
SDP	0.2830031D+00	0.08130	12.116
SDQ	0.2650667D+00	0.07603	12.155
SDR	0.2542239D+00	0.06883	13.642
SDS	0.2365474D+00	0.08047	8.642
SDT	0.1642847D+00	0.07818	4.415
SDU	0.2254526D+00	0.07450	9.157
SDV	0.2039744D+00	0.07164	8.107
SDW	0.1286485D+00	0.08029	2.567
SDX	0.2522161D+00	0.09430	7.154
SDY	0.2138392D-01	0.10632	0.040
SDZ	0.2033662D+00	0.09664	4.429
SDAA	0.2304814D+00	0.08965	6.609
SDBB	0.1346784D+00	0.10468	1.655
SDCC	0.1574253D+00	0.08176	3.707
SDDD	0.1087792D+00	0.08381	1.684
SDEE	0.9910778D-01	0.08140	1.482
ZNA	0.1782351D+00	0.07789	5.236
ZNB	0.2157243D+00	0.07338	8.642
ZNE	-0.1269482D-01	0.04610	0.076
ZNF	-0.1822538D+00	0.04865	14.035
ZNG	0.1005317D+01	0.18990	28.027
ZNI	0.4584455D+00	0.11254	16.596

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ZNJ          0.1430776D+00      0.08447       2.869
ZNK         -0.3127513D+00      0.19122       2.675
ZNL         -0.9734848D+00      0.20489      22.573
ZNN          0.6620033D+00      0.13026      25.829
HDEN         0.1474943D-01      0.01406       1.100
PDEN         0.2089186D+00      0.08996       5.393
CLE         -0.7266492D+00      0.19646      13.681
CLF         -0.6984778D+00      0.18777      13.838
CLG         -0.3989091D+00      0.18356       4.723
CLH         -0.4836872D+00      0.18862       6.576
CLI         -0.4342772D+00      0.29643       2.146
CONB         0.2624463D+00      0.14447       3.300
CONF         0.1506241D+00      0.11267       1.787
PLG          0.3193317D+00      0.12847       6.178
PLV          0.1163286D+00      0.04248       7.497
DPW          0.1495537D+00      0.06322       5.596
DAC         -0.1735949D+00      0.09510       3.332
DD12         0.3115856D+00      0.17165       3.295
DD2         -0.1341313D+00      0.08833       2.306
DD3         -0.1349940D+00      0.08688       2.414
DD4         -0.1762974D+00      0.08769       4.042
DD5         -0.1151528D+00      0.08836       1.698
DD6         -0.1381083D+00      0.10354       1.779
DD7          0.1382624D-01      0.09243       0.022
DD8          0.1317168D+00      0.09936       1.757
DD9          0.8355525D-01      0.10835       0.595
DD11         0.4864406D+00      0.22318       4.750
(Constant)   0.3735413D+01


Analysis of variance     Df   Sum of squares  Mean square      F
Regression               78.        56.18608      0.72033  26.59177
Residual                360.         9.75190      0.02709


                 Multiple R              0.92310
                 R square                0.85210
                 Adjusted R square       0.82006
                 Standard error          0.16459
```

TABLE 4

PROPERTY VALUES REGRESSED ON THE LINEAR AND RECIPROCAL FORMS OF DISTANCE FROM THE WASTE SITE (STEPWISE INCLUSION)---SAMPLE I

------------------ Variables in the equation ------------------

Variable	B	Std error B	F
HARE	0.1031593D-01	0.00201	26.301
CLF	-0.5910843D+02	10.99238	28.915
CLE	-0.5677199D+02	11.56209	24.110
SDB	0.3425728D+02	3.08249	123.510
OTBF	0.1901425D-02	0.00069	7.645
SDJ	0.1932109D+02	2.55590	57.144
CLI	0.1321864D+02	17.14257	0.595
DAC	-0.5699830D+01	5.11087	1.244
AIP	-0.2134245D+01	1.21177	3.102
CLH	-0.4504148D+02	11.12595	16.389
SDY	-0.6341829D+01	4.83445	1.721
SDF	0.2296530D+02	3.23757	50.316
SDE	0.1635903D+02	3.23946	25.502
SDG	0.1910920D+02	3.59998	28.176
SDC	0.2119712D+02	3.73287	32.245
SDL	0.1333865D+02	2.53217	27.748
SDI	0.1708776D+02	3.08894	30.502
GRG	0.4150799D+01	1.09230	14.427
ZNN	0.3936525D+02	8.06785	23.807
BTR	0.2151424D+01	1.37764	2.439
CLG	-0.3411364D+02	10.68528	10.193
PLV	0.8815244D+01	2.53929	12.052
ZNA	0.1650063D+01	3.53941	0.217
COND	-0.6500461D+01	2.56133	6.441
BMT	-0.4508986D+01	1.35828	11.020
SDM	0.9214373D+01	2.31783	15.804
SDK	0.1148542D+02	2.59651	19.566
SDD	0.1639496D+02	4.41997	13.759
ZNG	0.4429092D+02	13.95369	10.075
DWDD	0.3764410D+01	1.43669	6.865
FPL	-0.3258752D+01	1.36098	5.733
SDN	0.6941930D+01	2.25636	9.465
SDH	0.1159815D+02	4.80988	5.814
SDO	0.5569004D+01	2.37496	5.498
SDA	0.1557006D+02	5.42827	8.227
PLG	0.1503347D+02	7.73497	3.777
ZNI	0.1259634D+02	6.98653	3.251
SDR	0.3494099D+01	1.93196	3.108
DHS	-0.6008192D+01	6.43366	0.872
LSZ	-0.2996308D-01	0.01225	5.592
RND	0.2517215D+01	1.87486	1.303
MDK	-0.3796881D+01	2.26490	2.810
SDP	0.5107473D+01	3.34389	2.333
PDEN	0.1216775D+02	4.90546	6.153
DWD	0.1078510D+02	3.40811	10.014
DCRD	0.5703194D+01	2.77755	4.216
ZNF	-0.5086499D+01	2.56969	3.918
ZNB	0.7471444D+01	3.90000	3.366
SDQ	0.4248203D+01	2.64809	2.574
ATT	-0.5440821D+01	3.41218	2.543
DPW	0.4668637D+01	3.25612	2.056
ZNK	-0.1617247D+02	11.55242	1.960
ZNE	-0.2994181D+01	2.24955	1.772
UTWW	0.2621253D+01	2.03573	1.579
AGE	-0.5774738D-01	0.05290	1.191
(Constant)	0.4968422D+02		

```
------------- Variables not in the equation --------------

                 Variable       F

                 BMTC         0.271
                 RM           0.044
                 BDR          0.186
                 PTC          0.123
                 DNS          0.235
                 DAR          0.746
                 SDS          0.537
                 SDT          0.261
                 SDU          0.309
                 SDV          0.626
                 SDW          0.212
                 SDX          0.022
                 SDZ          0.599
                 SDAA         0.185
                 SDBB         0.084
                 SDCC         0.734
                 SDDD         0.060
                 SDEE         0.155
                 ZNC          0.033
                 ZND          0.277
                 ZNJ          0.118
                 ZNL          0.951
                 ZNM          0.041
                 HDEN         0.242
                 UTSS         0.001
                 UTST         0.034
                 UTWC         0.112
                 CONB         0.645
                 CONF         0.592
                 DLF          0.001


Analysis of variance    Df     Sum of squares Mean square     F
Regression              55.      194176.56800  3530.48305  34.17950
Residual               383.       39560.99660   103.29242

                    Multiple R                0.91145
                    R square                  0.83075
                    Adjusted R square         0.80644
                    Standard error           10.16329
```

TABLE 5

PROPERTY VALUES REGRESSED ON THE QUADRATIC FORM OF DISTANCE FROM THE WASTE SITE (STEPWISE INCLUSION)---SAMPLE I

------------------ Variables in the equation ------------------

Variable	B	Std error B	F
HARE	0.1027566D-01	0.00203	25.636
CLF	-0.5774571D+02	11.01614	27.478
CLE	-0.5372847D+02	11.57700	21.539
SDB	0.3516270D+02	3.20352	120.478
DTRF	0.1941875D-02	0.00074	6.978
SDJ	0.2149525D+02	2.76249	60.546
CLI	0.1481969D+02	17.72562	0.699
DAC	-0.1354733D+01	5.48031	0.061
AIR	-0.1692034D+01	1.23274	1.884
CLH	-0.4407599D+02	11.17489	15.557
SDY	-0.3683196D+01	4.95875	0.552
SDF	0.2390285D+02	3.39341	49.617
SDE	0.1821030D+02	3.41886	28.371
SDG	0.2092960D+02	3.72192	31.622
SDC	0.2332283D+02	3.87605	36.206
SDL	0.1402360D+02	2.77444	25.549
SDI	0.1860984D+02	3.25474	32.693
GRG	0.4687440D+01	1.10286	18.065
ZNN	0.4964094D+02	8.81109	31.741
BTR	0.2696125D+01	1.39906	3.714
CLG	-0.3348528D+02	10.75377	9.696
PLV	0.9176957D+01	2.55406	12.910
ZNA	0.5059047D+01	4.98269	1.031
COND	-0.5429840D+01	2.62583	4.276
BMT	-0.3622115D+01	1.37117	6.978
SDM	0.1119438D+02	2.58360	18.771
SDK	0.1278920D+02	2.80945	20.723
SDD	0.1792456D+02	4.62458	15.023
ZNG	0.4478125D+02	14.76378	9.200
FPL	-0.2708303D+01	1.39903	3.747
SDN	0.8266206D+01	2.51732	10.783
SDH	0.1280600D+02	4.87319	6.906
ZNI	0.2387871D+02	7.04295	11.495
SDA	0.1803431D+02	5.53991	10.597
SDO	0.7922287D+01	2.59298	9.335
SDR	0.5683382D+01	2.22657	6.515
PLG	0.1594032D+02	7.73825	4.189
RMD	0.2665379D+01	1.89722	1.974
ZNB	0.1340935D+02	4.70149	8.135
MDK	-0.2444523D+01	2.23568	1.196
ZNJ	0.4565393D+01	4.36488	1.094
LSZ	-0.3251925D-01	0.01257	6.695
SDP	0.6827946D+01	3.45821	3.898
SDQ	0.6339404D+01	2.85075	4.945
DLF	-0.1136729D+01	4.88556	0.054
ZNK	-0.1777753D+02	11.52577	2.379
ATT	-0.7549840D+01	3.55013	4.523
DHS	-0.8209323D+01	7.12349	1.328
DAR	-0.8094484D+01	3.33088	5.906
DNS	-0.2911678D+01	5.39271	0.244
DWD	0.8287996D+01	3.03449	7.460

```
 DCBD          0.2355861D+01        2.59752         0.823
 AGE          -0.8774528D-01        0.05345         2.695
 UTWW          0.4276434D+01        2.21263         3.735
 SDS           0.4790301D+01        3.27728         2.136
 CONB          0.1963155D+02        8.83690         4.935
 CONF          0.1373660D+02        7.17445         3.666
 SDV           0.3417561D+01        2.52494         1.832
 SDT           0.4072118D+01        3.20264         1.617
 SDU           0.3220274D+01        2.77416         1.347
 PDEN          0.1092292D+02        6.04426         3.266
 ZND           0.7411756D+01        4.32250         2.940
 DPW           0.5879509D+01        4.81232         1.493
 (Constant)    0.4928535D+02
```

```
------------- Variables not in the equation -------------

                 Variable       F

                 BMTC         0.000
                 RMS          0.009
                 BDR          0.094
                 PTD          0.000
                 SDW          0.119
                 SDX          0.074
                 SDZ          0.079
                 SDAA         0.292
                 SDBB         0.026
                 SDCC         0.048
                 SDDD         0.466
                 SDEE         0.137
                 ZNC          0.148
                 ZNE          0.171
                 ZNF          0.486
                 ZNL          0.343
                 ZNM          0.492
                 HDEN         0.374
                 UTSS         0.092
                 UTST         0.107
                 UTWC         0.026
                 DWDSQ        0.020
```

```
Analysis of variance    Df   | Sum of squares  Mean square       F
Regression              63.  |   194901.24700   3093.67058   29.87221
Residual               375.  |    38836.31790    103.56351
                   ------------------------------------------
                   Multiple R                0.91315
                   R square                  0.83385
                   Adjusted R square         0.80593
                   Standard error           10.17662
```

TABLE 6

NATURAL LOG OF PROPERTY VALUES REGRESSED ON THE LINEAR AND RECIPROCAL FORMS OF DISTANCE FROM THE WASTE SITE (STEPWISE INCLUSION)---SAMPLE I

----------------- Variables in the equation ------------------

Variable	B	Std error B	F
HARE	0.1581285D-03	0.00003	21.034
CLG	-0.2890192D+00	0.17465	2.739
OTBF	0.2903391D-04	0.00001	6.500
ZNL	-0.9913069D+00	0.20326	23.784
SDB	0.7203541D+00	0.07824	84.764
DACM	-0.1233424D+00	0.08833	1.950
AIR	-0.3648726D-01	0.02016	3.276
SDJ	0.5349082D+00	0.07611	49.400
SDF	0.6213972D+00	0.08036	59.789
FPL	-0.8129915D-01	0.02265	12.888
SDG	0.5910243D+00	0.08464	48.754
COND	-0.1863366D+00	0.04235	19.358
ZNF	-0.2043819D+00	0.04860	17.686
SDE	0.5297344D+00	0.08293	40.800
SDC	0.6048251D+00	0.08792	47.328
SDI	0.5426335D+00	0.07974	46.304
SDL	0.4506255D+00	0.07443	36.657
GRG	0.5900786D-01	0.01835	10.337
ZNN	0.5925513D+00	0.12686	21.817
PLG	0.3284492D+00	0.12796	6.588
SDM	0.3678673D+00	0.07317	25.279
SDK	0.4261770D+00	0.07538	31.967
BTR	0.5584054D-01	0.02367	5.566
SDD	0.5494741D+00	0.09626	32.582
SDN	0.3361348D+00	0.07229	21.622
ZNI	0.3082582D+00	0.12113	6.476
SDA	0.5789242D+00	0.11026	27.568
ZNJ	0.1079104D+00	0.08219	1.724
ZNG	0.5950191D+00	0.24405	5.945
ZNB	0.2039044D+00	0.07287	7.830
SDY	0.4524690D-01	0.10598	0.182
BMT	-0.6062913D-01	0.02292	6.995
PLV	0.9737867D-01	0.04184	5.418
RMD	0.5764803D-01	0.03100	3.458
SDO	0.3181329D+00	0.07289	19.050
HDEN	0.2562567D-01	0.01398	3.359
SDR	0.2571647D+00	0.06900	13.891
SDP	0.3019673D+00	0.08137	13.771
ZNK	-0.4836898D+00	0.19818	5.957
SDEE	0.1269789D+00	0.08197	2.476
AGE	-0.1039844D-02	0.00089	1.370
PDEN	0.1856365D+00	0.08221	5.099
SDQ	0.2813282D+00	0.07643	13.550
BDR	-0.8965289D-02	0.01547	0.336
DWD	0.1760260D+00	0.05628	9.781
DWDD	0.5196087D-01	0.02696	3.713
DNS	-0.3367235D-01	0.09314	0.131
SDH	0.3170352D+00	0.10027	9.997
SDS	0.2636830D+00	0.08000	10.863
DHS	-0.1369526D+00	0.12520	1.232
SDU	0.2307811D+00	0.07449	9.600

```
SDX          0.2694191D+00        0.09473      8.089
SDV          0.2012269D+00        0.07187      7.833
SDAA         0.2484222D+00        0.08989      7.637
SDT          0.1963492D+00        0.07309      6.323
CLE         -0.6188376D+00        0.18878     10.745
CLF         -0.5995365D+00        0.17982     11.116
CLH         -0.4133664D+00        0.18203      5.157
DPW          0.1533116D+00        0.06005      6.517
ATT         -0.1096934D+00        0.05953      3.396
SDZ          0.2239061D+00        0.09755      5.269
SDCC         0.1615247D+00        0.08099      3.977
SDW          0.1412962D+00        0.08047      3.083
DCBD         0.7600330D-01        0.04600      2.730
ZNA          0.1068945D+00        0.07960      1.803
MDK         -0.4191825D-01        0.03778      1.231
UTST         0.6807917D-01        0.03692      3.400
ZNE         -0.6690605D-01        0.04891      1.871
DAR         -0.4807488D-01        0.05591      0.739
SDDD         0.1164183D+00        0.08418      1.913
SDBB         0.1085691D+00        0.10445      1.080
CLI         -0.2830152D+00        0.28952      0.956
CONB         0.3351771D+00        0.14456      5.376
CONF         0.2608570D+00        0.11706      4.966
(Constant)   0.3193879D+01

------------- Variables not in the equation --------------

              Variable          F

              LSZ             0.766
              BMTC            0.001
              RMS             0.311
              PTO             0.086
              ZNC             0.262
              ZND             0.023
              ZNM             0.217
              UTSS            0.148
              UTWC            0.000
              UTWW            0.107
              DLFM            0.167


Analysis of variance    Df     Sum of squares Mean square     F
Regression              74.       56.07472      0.75777  27.96507
Residual               364.        9.86327      0.02710

               Multiple R               0.92218
               R square                 0.85042
               Adjusted R square        0.82001
               Standard error           0.16461
```

TABLE 7

NATURAL LOG OF PROPERTY VALUES REGRESSED ON THE CONTAMINATED ZONE (INSIDE) —SAMPLE 2

----------------- Variables in the equation ------------------

Variable	B	Std error B	F
LSZ	-0.6819917D-02	0.00837	0.663
GRG	0.1445961D+00	0.06213	5.416
RMD	0.2942320D-01	0.48834	0.004
AGE	0.8129318D-02	0.00747	1.184
COND	-0.4604943D+00	0.27727	2.758
BMT	0.6964487D-01	0.09791	0.506
ATT	-0.1534347D+00	0.37087	0.171
AIR	-0.9860572D-01	0.03607	7.475
FPL	-0.1998702D+00	0.13074	2.337
BTR	0.1889281D+00	0.08834	4.574
MDK	0.6645335D-01	0.31598	0.044
HARE	0.8590898D-04	0.00009	0.828
OTBN	-0.5665006D-01	0.15558	0.133
DHS	-0.7981447D+00	0.36380	4.813
DCBD	-0.1272682D+00	0.14148	0.809
SDGG	0.5831868D+00	0.12509	21.734
SDHH	0.4588890D+00	0.12329	13.854
SDII	0.5533876D+00	0.12974	18.195
SDJJ	0.5050201D+00	0.13235	14.560
SDKK	0.4474733D+00	0.12494	12.828
SDLL	0.4037647D+00	0.12289	10.795
SDMM	0.3215109D+00	0.12720	6.389
SDNN	0.2411567D+00	0.13725	3.087
SDOO	0.3239602D+00	0.12631	6.578
SDPP	0.2967105D+00	0.12800	5.374
SDQQ	0.2927053D+00	0.12327	5.638
SDRR	-0.1203839D+00	0.14728	0.668
SDSS	0.1987678D+00	0.12345	2.592
SDTT	0.1567784D+00	0.12671	1.531
SDUU	0.3008422D+00	0.17737	2.877
SDVV	0.1093049D+00	0.15758	0.481
SDWW	0.1023685D+01	0.52603	3.787
SDXX	0.2255574D-01	0.13164	0.029
ZNA	0.4997885D+00	0.32693	2.337
ZNB	0.1108579D+01	0.36566	9.191
ZNE	0.3325860D+00	0.42254	0.620
ZNF	0.2494390D+00	0.44577	0.313
PDEN	0.6564516D-01	0.15316	0.184
CLE	-0.8334899D+00	0.86614	0.926
CLF	-0.3269028D+00	0.51588	0.402
CLG	-0.1098108D+00	0.22163	0.245
CONF	-0.3061134D-01	0.05796	0.279
PLG	-0.2537992D-01	0.15624	0.026
PLV	-0.2505800D+00	0.11471	4.772
DPW	0.2881782D-01	0.35332	0.007
DAC	-0.4895492D-01	0.38461	0.016
(Constant)	0.4092786D+01		

```
Analysis of variance     Df  |Sum of squares Mean square    F
Regression               46. |    12.59365      0.27377  15.64744
Residual                 99. |     1.73215      0.01750
                             |
                 Multiple R            0.93760
                 R square              0.87909
                 Adjusted R square     0.82291
                 Standard error        0.13227
```

TABLE 8

NATURAL LOG OF PROPERTY VALUES REGRESSED ON THE CONTAMINATED ZONE (OUTSIDE) —SAMPLE 2

```
----------------- Variables in the equation ------------------

    Variable             B          Std error B          F

      LSZ       -0.5837911D-02        0.01213          0.232
      GRG       -0.1404871D-02        0.06436          0.000
      AGE       -0.4875386D-03        0.00204          0.057
      COND      -0.1453875D+00        0.19539          0.554
      BMT       -0.1016269D+00        0.07265          1.957

      AIR        0.7479010D-01        0.09071          0.680
      FPL       -0.4556646D-01        0.08149          0.313
      BTR        0.6774946D-01        0.08318          0.663
      MDK        0.7297769D-01        0.17719          0.170
      HARE       0.2342323D-03        0.00012          3.878
      OTBN       0.4026197D-01        0.19220          0.044
      DCBD      -0.2350241D+00        0.19964          1.386
      SDGG       0.4523271D+00        0.18887          5.736
      SDHH       0.6340299D+00        0.16390         14.964
      SDII       0.5464760D+00        0.19725          7.675
      SDJJ       0.5742472D+00        0.18308          9.838
      SDKK       0.5241643D+00        0.17536          8.935
      SDLL       0.5207153D+00        0.18352          8.051
      SDMM       0.4747803D+00        0.18412          6.649
      SDNN       0.5180932D+00        0.18864          7.543
      SDOO       0.4266260D+00        0.19204          4.935
      SDPP       0.3955047D+00        0.18439          4.601
      SDQQ       0.4040966D+00        0.18001          5.039
      SDRR       0.2843121D+00        0.22691          1.570
      SDSS       0.3256926D+00        0.17123          3.618
      SDTT       0.2956465D+00        0.17173          2.964
      SDUU       0.3706167D+00        0.18919          3.837
      SDVV       0.2404290D+00        0.19274          1.556
      SDWW       0.1479396D+00        0.20302          0.531
      SDXX       0.8232219D-01        0.21355          0.149
      SDYY       0.1236185D+00        0.23005          0.289
      SDZZ       0.1222910D+00        0.23302          0.275
      SDAAA     -0.3398084D-01        0.24316          0.020
      ZNA        0.6048980D+00        1.05587          0.328
      ZNE        0.5969912D-01        0.09678          0.381
      ZNC        0.8354587D+00        0.69516          1.444

      PDEN      -0.4782262D+00        0.57504          0.692

      PLG       -0.6498730D-01        0.15976          0.165
      PLV        0.8305378D-01        0.09538          0.758
      DPW        0.2589637D+00        0.30137          0.738
      DAC       -0.1497355D+00        0.25416          0.347
    (Constant)   0.2895663D+01

Analysis of variance     Df     Sum of squares   Mean square   F
Regression               44.       3.24015          0.07364   3.96761
Residual                 25.       0.46401          0.01856

             Multiple R                0.93527
             R square                  0.87473
             Adjusted R square         0.65427
             Standard error            0.13624
```

TABLE 9

NATURAL LOG OF PROPERTY VALUES REGRESSED ON THE CONTAMINATED ZONE (INSIDE) —SAMPLE I

----------------- Variables in the equation ------------------

Variable	B	Std error B	F
LSZ	0.2173892D-02	0.00100	4.766
GRG	0.2684316D-01	0.01801	2.222
RMD	0.1305134D-01	0.02834	0.212
AGE	-0.3037089D-02	0.00123	6.140
COND	0.8665669D-02	0.05646	0.024
BMT	-0.6861142D-01	0.01825	14.136
ATT	0.1194559D-01	0.08410	0.020
AIR	-0.4915612D-01	0.01549	10.064
FPL	-0.7015348D-01	0.01853	14.330
BTR	0.6059949D-01	0.01847	10.767
MDK	-0.8972679D-02	0.03684	0.059
HARE	0.1466135D-03	0.00003	26.969
OTBN	0.4595869D-01	0.02644	3.022
DHS	0.1152818D-01	0.10920	0.011
DCBD	0.4584074D-01	0.03922	1.366
SDA	0.5683685D+00	0.09366	36.822
SDB	0.5533519D+00	0.07138	60.090
SDC	0.5332310D+00	0.08687	37.674
SDD	0.4031595D+00	0.08769	21.140
SDE	0.4339889D+00	0.07368	34.696
SDF	0.5049305D+00	0.07227	48.811
SDG	0.5407909D+00	0.07124	57.620
SDH	0.4891024D+00	0.08355	34.268
SDI	0.4471235D+00	0.07045	40.276
SDJ	0.5063039D+00	0.06891	53.961
SDK	0.3809037D+00	0.06737	31.968
SDL	0.3381960D+00	0.06453	27.470
SDM	0.2798276D+00	0.06419	19.004
SDN	0.2756809D+00	0.06354	18.825
SDO	0.2346522D+00	0.06610	12.601
SDP	0.2106066D+00	0.07314	8.291
SDQ	0.2152069D+00	0.06820	9.957
SDR	0.1471857D+00	0.06257	5.534
SDS	0.1546239D+00	0.06881	5.049
SDT	0.1291084D+00	0.07146	3.264
SDU	0.1340808D+00	0.06587	4.143
SDV	0.9697248D-01	0.06474	2.244
SDW	0.6237237D-01	0.07222	0.746
SDX	0.1353447D+00	0.08025	2.845
SDY	-0.5887366D-01	0.08217	0.513
SDZ	0.1052079D+00	0.08268	1.619
SDAA	0.1823079D+00	0.07477	5.944
SDBB	0.1137616D+00	0.08613	1.745
SDCC	-0.3934895D-01	0.08724	0.203
SDDD	-0.7608583D-02	0.07043	0.012
SDEE	0.4727110D-01	0.08016	0.348
ZNA	0.7881166D-01	0.07023	1.259
ZNB	0.1664639D-01	0.06411	0.067
ZNE	-0.3581242D-01	0.05556	0.415

```
ZNF          -0.1551878D+00           0.05497       7.970
ZNJ           0.1224981D+00           0.08861       1.911

PDEN          0.1738498D+00           0.08363       4.322
CLE          -0.5973397D+00           0.09490      39.617
CLF          -0.3451717D+00           0.06601      27.341
CLG          -0.7910481D-01           0.05643       1.965
CONF         -0.3164405D-01           0.08573       0.136
PLG           0.6063606D+00           0.15678      14.958
PLV           0.1740628D+00           0.04275      16.580
DPW           0.1112325D+00           0.06084       3.342
DAC          -0.4467084D-01           0.06342       0.496
(Constant)    0.3177013D+01


Analysis of variance        Df      Sum of squares Mean square    F
Regression                  61.          37.43684      0.61372  51.31419
Residual                   253.           3.02589      0.01196

                  Multiple R              0.96188
                  R square                0.92522
                  Adjusted R square       0.90719
                  Standard error          0.10936
```

TABLE 10

NATURAL LOG OF PROPERTY VALUES REGRESSED ON THE CONTAMINATED ZONE (OUTSIDE) ---SAMPLE I

```
----------------- Variables in the equation ------------------

 Variable          B                  Std error b        F

 LSZ         0.5136847D-04           0.00010          0.286
 GRG        -0.1488355D-01           0.02914          0.261
 RMD         0.4989473D-01           0.03848          1.682
 AGE         0.1251198D-02           0.00150          0.700
 COND       -0.3240425D+00           0.05523         34.417
 BMT        -0.1353050D-01           0.03270          0.171
 ATT         0.1682618D+00           0.18564          0.322
 AIR         0.2318964D-01           0.03042          0.581
 FPL        -0.4867388D-01           0.03587          1.842
 BTR         0.8072236D-01           0.04636          3.031
 MDK        -0.1107964D+00           0.08291          1.786
 HARE        0.2160081D-03           0.00006         11.870
 OTBN       -0.1111499D-01           0.04978          0.050
 DCBD        0.3078687D-01           0.07566          0.166
 SDA         0.5533456D+00           0.15808         12.253
 SDB         0.4634964D+00           0.09670         22.972
 SDC         0.5052464D+00           0.10488         23.209
 SDD         0.4566030D+00           0.10528         18.809
 SDE         0.2989527D+00           0.09896          9.127
 SDF         0.5738703D+00           0.11152         26.480
 SDG         0.4877552D+00           0.10702         20.771
 SDH         0.5291990D+00           0.15356         11.877
 SDI         0.5625615D+00           0.11499         23.932
 SDJ         0.4204164D+00           0.09875         18.125
 SDK         0.2443769D+00           0.09720          6.322
 SDL         0.6245462D-01           0.13174          0.225
 SDM         0.2746435D+00           0.10955          6.285
 SDN         0.1513450D+00           0.11459          1.744
 SDO         0.1589423D+00           0.09298          2.922
 SDP         0.1601999D+00           0.10939          2.145
 SDQ         0.1185315D+00           0.09589          1.528
 SDR         0.1330919D+00           0.10021          1.764
 SDS         0.1898929D+00           0.10536          3.248
 SDT         0.7886437D-01           0.09627          0.671
 SDU         0.1442617D+00           0.09634          2.242
 SDV         0.4520612D-01           0.10709          0.178
 SDW         0.4989350D-01           0.10461          0.227
 SDX         0.1323244D+00           0.10747          1.516
 SDY         0.4331620D-01           0.12363          0.123
 SDZ        -0.5728999D-01           0.15022          0.145
 SDAA        0.2455082D+00           0.12498          3.859
 SDBB       -0.7810971D-01           0.14914          0.274
 SDCC        0.9728931D-01           0.09148          1.131
 SDDD        0.1529712D+00           0.15018          1.037
 SDEE        0.9521472D-02           0.08868          0.012
 ZNA         0.3034887D+00           0.19730          2.366

 ZNE         0.2661190D-01           0.05236          0.258
 ZNJ          0.2282806D+00
 ZNO          0.3379387D+00       0.14829        2.370
 PDEN        -0.1678043D+00       0.20236        2.789
                                  0.22457        0.558
 CLF          0.2932526D-01
 CLG          0.2498595D+00       0.20270        0.021
                                  0.18355        1.353
 PLG         -0.9251763D-01
 PLV          0.1015076D+00       0.14617        0.401
 DPW         -0.7015136D-02       0.04604        4.860
 DAC         -0.9198896D-01       0.11645        0.004
 (Constant)   0.1206839D+02       0.15241        0.364



Analysis of variance     Df     Sum of squares  Mean square   F
Regression               61.          11.78511      0.19320  13.33018
Residual                 82.           1.18845      0.01449

                         Multiple R               0.95310
                         R square                 0.90839
                         Adjusted R square        0.84025
                         Standard error           0.12039
```

TABLE II

NATURAL LOG OF PROPERTY VALUES REGRESSED ON EXPLANATORY VARIABLES WITHOUT THE DISTANCE FROM WASTE SITE VARIABLES---SAMPLE 2

----------------- Variables in the equation ------------------

Variable	B	Std error B	F
LSZ	0.3180888D-02	0.00256	1.538
GRG	0.5858888D-01	0.03265	3.219
RMD	0.1449305D-01	0.28435	0.003
AGE	-0.2596135D-03	0.00152	0.029
COND	-0.1960907D+00	0.10269	3.647
BMT	0.1905789D-01	0.03922	0.236
ATT	-0.2557470D+00	0.14155	3.264
AIR	-0.6318866D-01	0.03122	4.096
FPL	-0.5813171D-01	0.04814	1.458
BTR	0.8897184D-01	0.04744	3.518
MDK	-0.6279474D-01	0.10499	0.358
HARE	0.1991055D-03	0.00006	13.075
OTBN	0.2974834D-02	0.06709	0.002
DHS	-0.3524087D+00	0.24239	2.114
DCBD	-0.5474409D-01	0.05092	1.156
SDGG	0.6108305D+00	0.10182	35.991
SDHH	0.5348327D+00	0.09537	31.450
SDII	0.5739247D+00	0.09965	33.172
SDJJ	0.6005285D+00	0.10161	34.932
SDKK	0.5128192D+00	0.10209	25.231
SDLL	0.4888481D+00	0.09840	24.679
SDMM	0.4081794D+00	0.09951	16.824
SDNN	0.4189944D+00	0.10262	16.671
SDOO	0.3527259D+00	0.09930	12.618
SDPP	0.3348092D+00	0.09750	11.791
SDQQ	0.3625086D+00	0.09956	13.259
SDRR	-0.4871968D-01	0.11572	0.177
SDSS	0.2714478D+00	0.09686	7.855
SDTT	0.2454167D+00	0.10014	6.007
SDUU	0.3300648D+00	0.12154	7.375
SDVV	0.1961489D+00	0.11497	2.911
SDWW	0.1468604D+00	0.12514	1.377
SDXX	0.6017468D-01	0.11364	0.280
SDYY	0.1869373D+00	0.17298	1.168
SDZZ	-0.3899944D-01	0.17735	0.048
SDAAA	-0.4710018D-01	0.17981	0.069
ZNA	-0.2577305D+00	0.24168	1.137
ZNB	0.1435782D+00	0.28703	0.250
ZNE	0.1199209D-01	0.05760	0.043
ZNF	-0.6106137D-01	0.07579	0.649
ZNJ	-0.5461998D+00	0.21219	6.626
ZNO	-0.1537400D+00	0.26308	0.342
PDEN	-0.1000026D-01	0.09239	0.012
CLE	-0.8577458D+00	0.33704	6.477
CLF	-0.4669819D+00	0.22571	4.281
CLG	-0.2409802D+00	0.17513	1.893
CONF	-0.5462353D-01	0.05879	0.863
PLG	-0.4267182D-01	0.10852	0.155
PLV	-0.3615324D-01	0.05887	0.377
DPW	-0.2150514D-01	0.14145	0.023
DAC	0.6289453D-01	0.11536	0.297
(Constant)	0.3835531D+01		

```
Analysis of variance      Df      Sum of squares  Mean square     F
 Regression               51.           17.05917      0.33449  16.59599
 Residual                164.            3.30543      0.02016

                       Multiple R              0.91525
                       R square                0.83769
                       Adjusted R square       0.78721
                       Standard error          0.14197
```

TABLE I2

NATURAL LOG OF PROPERTY VALUES REGRESSED ON THE EXPLANATORY VARIABLES WITHOUT DISTANCE FROM WASTE SITE VARIABLES---SAMPLE I

----------------- Variables in the equation -----------------

Variable	B	Std error B	F
LSZ	0.8993941D-04	0.00008	1.190
GRG	0.3666329D-01	0.01345	7.427
RMD	0.3838031D-01	0.02187	3.079
AGE	-0.1242079D-02	0.00081	2.348
COND	-0.1717268D+00	0.03351	26.267
BMT	-0.4408540D-01	0.01464	9.073
ATT	-0.2731134D-01	0.06605	0.171
AIR	-0.4475692D-01	0.01374	10.611
FPL	-0.5626873D-01	0.01615	12.141
BTR	0.5568180D-01	0.01686	10.906
MDK	-0.6070939D-02	0.03075	0.039
HARE	0.2030069D-03	0.00002	74.763
OTBN	0.5517084D-01	0.02289	5.809
DHS	-0.2397435D+00	0.09176	6.826
DCBD	-0.9272131D-02	0.01613	0.330
SDA	0.4814722D+00	0.08123	35.133
SDB	0.5266037D+00	0.05817	81.957
SDC	0.5220483D+00	0.06631	61.984
SDD	0.4169617D+00	0.06757	38.075
SDE	0.3696959D+00	0.05988	38.123
SDF	0.5181137D+00	0.06150	70.983
SDG	0.4933128D+00	0.06041	66.693
SDH	0.4462979D+00	0.07367	36.697
SDI	0.4444106D+00	0.06036	54.212
SDJ	0.4511361D+00	0.05749	61.573
SDK	0.3190582D+00	0.05635	32.054
SDL	0.2911660D+00	0.05597	27.066
SDM	0.2631566D+00	0.05443	23.377
SDN	0.2183985D+00	0.05435	16.148
SDO	0.2012702D+00	0.05512	13.335
SDP	0.1779030D+00	0.06221	8.177
SDQ	0.1618513D+00	0.05691	8.088
SDR	0.1335359D+00	0.05277	6.403
SDS	0.1439938D+00	0.05849	6.060
SDT	0.8479724D-01	0.05789	2.146
SDU	0.1357276D+00	0.05526	6.032
SDV	0.6977960D-01	0.05521	1.597
SDW	0.4170007D-01	0.05953	0.491
SDX	0.1442295D+00	0.06393	5.090
SDY	-0.8922306D-02	0.06979	0.016
SDZ	0.1134009D+00	0.07223	2.465
SDAA	0.1640654D+00	0.06430	6.511
SDBB	0.4299222D-01	0.07762	0.307
SDCC	0.6541850D-01	0.06050	1.169
SDDD	-0.2357352D-01	0.06285	0.141
SDEE	0.1789590D-01	0.05738	0.097
ZNA	0.1197434D+00	0.05135	5.438
ZNB	0.9794919D-01	0.04923	3.958
ZNE	-0.1514362D-01	0.01819	0.693

```
            ZNF          -0.1422447D+00         0.02462        33.372
            ZNJ           0.3663889D-01         0.05275         0.482
            ZNO           0.1661759D+00         0.09363         3.150
            PDEN          0.1183258D+00         0.05709         4.296
            CLE          -0.4027271D+00         0.08073        24.883
            CLF          -0.2241130D+00         0.05898        14.436
            CLG           0.2266669D-02         0.05469         0.002
            CONF          0.1250825D-01         0.07716         0.026
            PLG           0.2508368D+00         0.09331         7.226
            PLV           0.1193732D+00         0.02925        16.652
            DPW           0.7581310D-01         0.03816         3.947
            DAC           0.3222479D-01         0.03577         0.812
            (Constant)    0.3559810D+01




Analysis of variance     Df      Sum of squares  Mean square    F
Regression               61.           47.68240      0.78168  53.77596
Residual                397.            5.77073      0.01454


                         Multiple R           0.94448
                         R square             0.89204
                         Adjusted R square    0.87545
                         Standard error       0.12056
```

TABLE 13

NATURAL LOG OF PROPERTY VALUES REGRESSED ON DISTANCE FROM THE WASTE SITE IN 1/4 MILE DUMMIES---SAMPLE I*

```
----------------- Variables in the equation ------------------

   Variable            B            Std error B        F

   LSZ         0.7026133D-04         0.00008        0.733
   GRG         0.3591352D-01         0.01352        7.058
   RMD         0.3666820D-01         0.02188        2.810
   AGE        -0.8258390D-03         0.00082        1.007
   COND       -0.1942121D+00         0.03421       32.222
   BMT        -0.4562630D-01         0.01482        9.475
   ATT        -0.2115351D-01         0.06610        0.102
   AIR        -0.4736956D-01         0.01378       11.810
   FPL        -0.5418020D-01         0.01598       11.488
   BTR         0.5021524D-01         0.01678        8.952
   MDK        -0.1048181D-03         0.03042        0.000
   HARE        0.1970493D-03         0.00002       67.680
   CTBN        0.5326857D-01         0.02290        5.411
   DHS        -0.2441186D+00         0.09124        7.158
   DCBD        0.6714824D-01         0.03454        3.778
   SDA         0.5269146D+00         0.08177       41.527
   SDB         0.5215213D+00         0.05814       80.475
   SDC         0.5256584D+00         0.06603       63.368
   SDD         0.4181499D+00         0.06731       38.594
   SDE         0.3709405D+00         0.05944       38.945
   SDF         0.5263129D+00         0.06130       73.717
   SDG         0.5047777D+00         0.06000       70.776
   SDH         0.4499628D+00         0.07316       37.830
   SDI         0.4421824D+00         0.06014       54.053
   SDJ         0.4517484D+00         0.05710       62.600
   SDK         0.3248611D+00         0.05614       33.479
   SDL         0.2993877D+00         0.05574       28.851
   SDM         0.2728404D+00         0.05427       25.276
   SDN         0.2165129D+00         0.05413       16.000
   SDO         0.2027391D+00         0.05491       13.634
   SDP         0.1728124D+00         0.06198        7.773
   SDQ         0.1730549D+00         0.05702        9.210
   SDR         0.1449897D+00         0.05268        7.576
   SDS         0.1392274D+00         0.05856        5.652
   SDT         0.7669973D-01         0.05789        1.755
   SDU         0.1449586D+00         0.05517        6.903
   SDV         0.8744582D-01         0.05514        2.515
   SDW         0.4650101D-01         0.05909        0.619
   SDX         0.1460706D+00         0.06340        5.308
   SDY        -0.1563236D-01         0.06941        0.051
   SDZ         0.1130896D+00         0.07188        2.475
   SDAA        0.1659748D+00         0.06386        6.754
   SDBB        0.6987773D-01         0.07754        0.812
   SDCC        0.8034077D-01         0.06025        1.778
   SDDD       -0.9556047D-02         0.06286        0.023
   SDEE        0.1141724D-01         0.05748        0.039
   ZNA         0.2040407D+00         0.05883       12.030
   ZNB         0.1233568D+00         0.05202        5.624
   ZNE         0.2799022D-02         0.01938        0.021
   ZNF        -0.1216826D+00         0.02614       21.664
```

* OBSERVATIONS WITH LOTS GREATER THAN TWO ACRES WERE OMMITTED FROM THIS EQUATION

```
ZNJ           0.9642344D-01      0.05612       2.952

PDEN          0.1587070D+00      0.01720      85.187
CLE          -0.3746172D+00      0.08199      20.875
CLF          -0.2328455D+00      0.05948      15.322
CLG          -0.1393948D-01      0.05513       0.064
CONF          0.1326346D-01      0.07632       0.030
PLG           0.2500297D+00      0.09349       7.152
PLV           0.1318546D+00      0.02982      19.546
DPW           0.1326055D+00      0.04567       8.431
DAC          -0.7784631D-01      0.05944       1.715

DD3           0.1986372D-01      0.02895       0.471
DD4          -0.3252786D-01      0.03189       1.040
DD5          -0.1703516D-01      0.03624       0.221
DD6          -0.5381074D-02      0.05910       0.008
DD7           0.4056868D-01      0.05973       0.461
DD8           0.1009461D+00      0.04439       5.170
DD9           0.1279459D+00      0.05307       5.811
DD10          0.3700288D-01      0.06143       0.363
(Constant)    0.3426490D+01



Analysis of variance     Df      Sum of squares  Mean square     F
Regression               70.          47.95352      0.68505  48.33062
Residual                388.           5.49961      0.01417


                  Multiple R            0.94716
                  R square              0.89711
                  Adjusted R square     0.87855
                  Standard error        0.11906
```

TABLE 14

NATUARAL LOG OF PROPERTY VALUES REGRESSED ON DISTANCE FROM THE WASTE SITE IN 1/4 MILE DUMMIES---SAMPLE 2

----------------- Variables in the equation ------------------

Variable	B	Std error B	F
LSZ	-0.1204275D-02	0.00235	0.263
GRG	0.9496992D-01	0.03597	6.972
RMD	-0.1825183D+00	0.13423	1.849
AGE	0.4657212D-04	0.00158	0.001
COND	-0.8635665D-01	0.13770	0.393
BMT	0.7399949D-01	0.04433	2.787
ATT	0.3005004D-02	0.27878	0.000
AIR	-0.1390952D+00	0.03165	19.310
FPL	-0.1347226D+00	0.04244	10.079
BTR	0.1360254D+00	0.05629	5.840
MDK	0.2738466D-02	0.10920	0.001
HARE	-0.4648125D-04	0.00006	0.674
OTBN	0.3577631D-01	0.07397	0.234
DHS	-0.8561767D+00	0.24951	11.775
DCBD	0.5384171D-01	0.08220	0.429
SDGG	0.5820821D+00	0.10345	31.659
SDHH	0.5173665D+00	0.09703	28.432
SDII	0.5551751D+00	0.10104	30.191
SDJJ	0.5739797D+00	0.10164	31.890
SDKK	0.4278548D+00	0.10162	17.725
SDLL	0.4467907D+00	0.09903	20.354
SDMM	0.3719044D+00	0.09889	14.144
SDNN	0.3737349D+00	0.10616	12.394
SDOO	0.3063373D+00	0.10297	8.852
SDPP	0.3046244D+00	0.09946	9.380
SDQQ	0.3454985D+00	0.10068	11.777
SDRR	-0.1428946D+00	0.11564	1.527
SDSS	0.2661741D+00	0.09870	7.273
SDTT	0.2339631D+00	0.10143	5.321
SDUU	0.3771342D+00	0.12624	8.924
SDVV	0.1348367D+00	0.11405	1.398
SDWW	0.2238950D+00	0.12882	3.021
SDXX	0.1140142D+00	0.11582	0.969
SDYY	0.1231775D+00	0.17542	0.493
SDZZ	-0.2212474D+00	0.16774	1.740
SDAAA	0.7780709D-01	0.18970	0.168
ZNB	0.6423296D-01	0.11361	0.320
ZNE	-0.1742809D+00	0.03174	30.147
ZNF	-0.4105700D+00	0.05399	57.826
ZNJ	-0.7355688D+00	0.16152	20.738
PDEN	-0.2079927D-01	0.09797	0.045
CLE	-0.1511653D+01	0.43615	12.013
CLF	-0.8272499D+00	0.28643	8.341
CLG	-0.3788843D+00	0.20889	3.290
CONF	-0.4686683D-01	0.06010	0.608
PLG	-0.1028585D+00	0.12126	0.720
PLV	-0.6629830D-01	0.06133	1.169
DPW	0.3459731D+00	0.09855	12.325
DAC	-0.3464927D+00	0.12682	7.465

```
DD4          -0.3350526D-01      0.04165        0.647
DD5           0.1558046D-01      0.05308        0.086
DD6           0.5553723D+00      0.32893        2.851
DD7           0.1762255D+00      0.11952        2.174
DD8           0.6300483D-01      0.10035        0.394
DD9           0.9618954D-01      0.13272        0.525
DD10          0.1961662D+00      0.18419        1.134
(Constant)    0.5051978D+01
```

```
Analysis of variance      Df    Sum of squares Mean square     F
Regression                58.         17.24487     0.29733  14.48801
Residual                 159.          3.26302     0.02052
```

```
Multiple R             0.91700
R square               0.84089
Adjusted R square      0.78285
Standard error         0.14326
```

TABLE 15

NATURAL LOG OF PROPERTY VALUES REGRESSED ON SEVERAL EXPLANATORY VARIABLES (SALES DATE TREND INTRODUCED,ATTIC AND MODERN KITCHEN OMMITTED)---SAMPLE I

```
----------------- Variables in the equation ------------------

 Variable          B              Std error B        F

 LSZ          0.6646125D-04        0.00008         0.745
 GRG          0.3557334D-01        0.01216         8.556
 RMD          0.3839875D-01        0.01984         3.746
 AGE         -0.6869976D-03        0.00070         0.965
 COND        -0.1952006D+00        0.03175        37.790
 BMT         -0.4480252D-01        0.01374        10.631
 AIR         -0.4686611D-01        0.01270        13.622
 FPL         -0.5358472D-01        0.01471        13.278
 BTR          0.5069867D-01        0.01538        10.868
 HARE         0.1959426D-03        0.00002        77.578
 OTBN         0.5450859D-01        0.02089         5.808
 DHS         -0.2218324D+00        0.08211         7.300
 DCBD         0.7601750D-01        0.03352         5.143
 SDTRND       0.9995657D+00        0.03766       704.309
 ZNA          0.2219123D+00        0.05731        14.994
 ZNB          0.1293247D+00        0.04741         7.440
 ZNE         -0.2231083D-02        0.01870         0.014
 ZNF         -0.1185310D+00        0.02440        23.596
 ZNJ          0.1008066D+00        0.04921         4.196
 PDEN         0.1127712D+00        0.05437         4.302
 CLE         -0.3705320D+00        0.07478        24.555
 CLF         -0.2317980D+00        0.05507        17.714
 CLG         -0.1297051D-01        0.05055         0.066
 PLG          0.2534911D+00        0.08669         8.551
 PLV          0.1320063D+00        0.02690        24.074
 DPW          0.1417449D+00        0.04357        10.584
 DAC         -0.1051107D+00        0.06427         2.675
 DD11         0.3169222D+00        0.10639         8.874
 DD3          0.2235809D-01        0.02708         0.682
 DD4         -0.3216226D-01        0.02930         1.205
 DD5         -0.1749314D-01        0.03333         0.275
 DD6          0.1064485D-01        0.05702         0.035
 DD7          0.5444437D-01        0.05602         0.944
 DD8          0.1067823D+00        0.04101         6.781
 DD9          0.1347454D+00        0.04865         7.671
 DD10         0.4195416D-01        0.05646         0.552
 (Constant)   0.3489126D+01


Analysis of variance      Df      Sum of squares   Mean square        F
Regression                36.          47.96234       1.33229    102.39436
Residual                 422.           5.49078       0.01301


                  Multiple R            0.94725
                  R square              0.89728
                  Adjusted R square     0.88852
                  Standard error        0.11407
```

TABLE 16

NATURAL LOG OF PROPERTY VALUES REGRESSED ON DISTANCE FROM THE WASTE SITE (IN 1/4 MILE DUMMIES) AND CONTAMINATED ZONES---SAMPLE I*

----------------- Variables in the equation ------------------

Variable	B	Std error B	F
GRG	0.2491917D-01	0.01311	3.611
RMD	0.4297150D-01	0.02103	4.174
AGE	-0.3236463D-03	0.00075	1.219
COND	-0.1962069D+00	0.03291	35.535
BMT	-0.4461240D-01	0.01449	9.473
AIR	-0.4644752D-01	0.01321	12.366
FPL	-0.5655868D-01	0.01556	13.214
BTR	0.5298096D-01	0.01625	10.632
DTBN	0.4581404D-01	0.02163	4.487
DHS	-0.1412910D+00	0.08728	2.621
DCBD	0.7940408D-01	0.03469	5.240
SDA	0.5341244D+00	0.07828	46.559
SDB	0.5298877D+00	0.05594	89.720
SDC	0.5321375D+00	0.06246	72.581
SDD	0.4376697D+00	0.06437	46.230
SDE	0.3717080D+00	0.05659	43.140
SDF	0.5245235D+00	0.05860	80.113
SDG	0.5053342D+00	0.05762	75.909
SDH	0.4730823D+00	0.07060	44.897
SDI	0.4443982D+00	0.05749	59.744
SDJ	0.4654597D+00	0.05432	73.733
SDK	0.3259558D+00	0.05355	37.046
SDL	0.2995756D+00	0.05334	31.538
SDM	0.2775915D+00	0.05192	28.586
SDN	0.2285436D+00	0.05174	19.514
SDO	0.2117196D+00	0.05273	16.123
SDP	0.1592426D+00	0.05955	7.150
SDQ	0.1778145D+00	0.05447	10.656
SDR	0.1465641D+00	0.05049	8.427
SDS	0.1428046D+00	0.05594	6.518
SDT	0.7604028D-01	0.05540	1.884
SDU	0.1417724D+00	0.05288	7.189
SDV	0.7943342D-01	0.05237	2.301
SDW	0.5399379D-01	0.05633	0.919
SDX	0.1163578D+00	0.06062	3.685
SDY	-0.1357384D-01	0.06681	0.041
SDZ	0.8467394D-01	0.06861	1.523
SDAA	0.1668619D+00	0.06157	7.344
SDBB	0.5860146D-01	0.07441	0.620
SDCC	0.8136971D-01	0.05776	1.984
SDDD	-0.9133866D-02	0.06003	0.023
SDEE	0.2417394D-01	0.05526	0.191
ZNA	0.1950747D+00	0.06772	8.298
ZNB	0.6866648D-01	0.05773	1.415
ZNE	-0.1051242D-01	0.02080	0.255
ZNF	-0.7089378D-01	0.02788	6.468
ZNJ	0.8674640D-01	0.05628	2.375
PDEN	0.9556747D-01	0.05639	2.872
CLE	-0.3562783D+00	0.07833	20.689
CLF	-0.2586253D+00	0.05689	20.671
CLG	-0.4819399D-01	0.05290	0.830

---

* LOT SIZE AND HOUSING AREA ARE IN NATURAL LOGS

```
PLG           0.2297853D+00        0.09069       6.420
PLV           0.1340474D+00        0.02870      21.818
DPW           0.1934419D+00        0.04869      15.787
DAC          -0.1437038D+00        0.06781       4.491
LSZLN         0.6157763D-01        0.01709      12.985
DD3           0.2285016D-01        0.02798       0.667
DD4          -0.2013840D-01        0.03073       0.430
DD5          -0.6301278D-02        0.03511       0.032
DD6           0.9622176D-01        0.06770       2.020
DD7           0.1840400D+00        0.06797       7.332
DD8           0.2338013D+00        0.06261      13.945
DD9           0.2695369D+00        0.07114      14.355
DD10          0.1803674D+00        0.07645       5.567
DD11          0.4075645D+00        0.13349       9.322
CTZD         -0.1357756D+00        0.04216      10.371
HRELN         0.2890352D+00        0.03868      55.931
(Constant)    0.1509243D+01
```

```
Analysis of variance      Df     Sum of squares   Mean square      F
Regression                67.         48.30386        0.72095   54.74425
Residual                 391.          5.14927        0.01317

                Multiple R            0.95061
                R square              0.90367
                Adjusted R square     0.88716
                Standard error        0.11476
```

TABLE 17

NATURAL LOG OF PROPERTY VALUES REGRESSED ON THE CONTAMINATED ZONES COMBINED (INSIDE AND OUTSIDE)---SAMPLE I

```
----------------- Variables in the equation ------------------

 Variable            B              Std error B          F

 GRG          0.2437827D-01          0.01227          3.948
 RMD          0.3989539D-01          0.01954          4.168
 AGE         -0.1592385D-02          0.00067          5.583
 COND        -0.1712935D+00          0.03071         31.103
 BMT         -0.3824126D-01          0.01351          8.013
 AIR         -0.4792110D-01          0.01241         14.900
 FPL         -0.5713845D-01          0.01461         15.298
 BTR          0.6090108D-01          0.01507         15.330
 HAELN        0.3069796D+00          0.03596         72.891
 LSZLN        0.7205465D-01          0.01565         21.196
 OTBN         0.5306921D-01          0.02048          6.713
 DHS         -0.1810332D+00          0.07907          5.242
 DCFD        -0.1529947D-02          0.02382          0.004
 SDTRND       0.1012019D+01          0.03734        734.639
 ZNA          0.1168346D-01          0.04559          0.065
 ZNB         -0.2093019D-01          0.04826          0.188
 ZNE         -0.3328409D-01          0.01739          3.664
 ZNF         -0.7651313D-01          0.02436          9.864
 ZNJ         -0.2201957D-01          0.04750          0.215
 PDEN         0.9812004D-01          0.05042          3.787
 CLE         -0.4054216D+00          0.07171         31.963
 CLF         -0.2577935D+00          0.05295         23.703
 CLG         -0.3014807D-01          0.04913          0.377
 PLC          0.2034675D+00          0.08578          5.627
 PLV          0.1269256D+00          0.02611         23.538
 DPN          0.6415287D-01          0.03266          3.858
 DAC          0.4277348D-01          0.03921          1.190
 CTZD        -0.1063501D-01          0.02647          0.161
 (Constant)   0.1450001D+01


Analysis of variance     Df      Sum of squares   Mean square      F
Regression               28.         47.90052        1.71073   132.48105
Residual                430.          5.55261        0.01291


            Multiple R                0.94664
            R square                  0.89612
            Adjusted R square         0.88936
            Standard error            0.11364
```

TABLE 18

NATURAL LOG OF PROPERTY VALUES REGRESSED ON DISTANCE FROM THE WASTE SITE IN 1/4 MILE DUMMIES—SAMPLE 2

```
----------------- Variables in the equation ------------------

   Variable            B               Std error B          F

   LSZ          0.3269258D-02           0.00272           1.443
   GRG          0.6943084D-01           0.03514           3.904
   RMD          0.1415041D+00           0.24754           0.327
   AGE         -0.9122084D-03           0.00161           0.322
   COND        -0.1564467D+00           0.11979           1.706
   BMT          0.3075912D-01           0.03989           0.594
   ATT         -0.5918996D-02           0.27832           0.000
   AIR         -0.7301544D-01           0.03210           5.173
   FPL         -0.4061233D-01           0.05048           0.647
   BTR          0.7163305D-01           0.04968           2.079
   MDK         -0.9687218D-01           0.10249           0.893
   HARE         0.1637733D-03           0.00006           8.151
   DTPN         0.8033022D-01           0.07377           1.186
   DHS         -0.4376411D+00           0.24929           3.082
   DCBD        -0.7115270D-01           0.06641           1.148
   SDGG         0.1031894D+01           0.17833          33.483
   SDHH         0.1023526D+01           0.18802          29.634
   SDII         0.1067541D+01           0.18375          33.755
   SDJJ         0.1065798D+01           0.18246          34.120
   SDKK         0.1152657D+01           0.24088          22.899
   SDLL         0.1112385D+01           0.22564          24.304
   SDMM         0.1100318D+01           0.27327          16.212
   SDNN         0.1166621D+01           0.28383          16.900
   SDOO         0.1153087D+01           0.34240          11.341
   SDPP         0.1120267D+01           0.33188          11.394
   SDQQ         0.1014081D+01           0.29312          11.969
   SDRR        -0.2639761D+00           0.83517           0.104
   SDSS         0.1074116D+01           0.37131           8.368
   SDTT         0.1003485D+01           0.43537           5.313
   SDUU         0.8843368D+00           0.33333           7.039
   SDVV         0.1523879D+01           0.86524           3.102
   SDWW         0.7208107D+00           0.57572           1.568
   SDXX         0.6754975D+00           1.01856           0.440
   SDYY         0.1444598D+01           1.42419           1.029
   SDZZ        -0.2537307D+00           0.80024           0.101
   SDAAA       -0.4369150D+00           2.36804           0.034
   ZNB          0.4122816D+00           0.19631           4.411
   ZNE          0.1494788D-01           0.05477           0.074
   ZNF         -0.7252365D-01           0.07971           0.828
   ZNJ         -0.4840108D+00           0.15943           9.216
   PDEN         0.6902861D-01           0.11558           0.357
   CLE         -0.8778760D+00           0.29759           8.702
   CLF         -0.4040948D+00           0.19977           4.092
   CLG         -0.2403295D+00           0.17848           1.813
```

```
CONF          -0.4580780D-01          0.06033          0.577
PLG           -0.7310758D-01          0.12065          0.367
PLV           -0.5946471D-01          0.06135          0.939
DPW            0.2329722D-02          0.10020          0.001
DAC            0.4877062D-03          0.02156          0.001
DD4            0.4109383D-02          0.03998          0.011
DD5            0.4758153D-01          0.05145          0.855
DD6            0.3476991D+00          0.32600          1.138
DD7            0.8277249D-01          0.10566          0.614
DD8            0.4030787D-01          0.09279          0.189
DD9            0.4556368D-01          0.11527          0.156
DD10           0.1741393D+00          0.16588          1.102
(Constant)     0.3327729D+01
```

```
Analysis of variance     Df     Sum of squares   Mean square      F
Regression               58.        17.11836        0.29514   14.27424
Residual                157.         3.24624        0.02068

                 Multiple R              0.91684
                 R square                0.84059
                 Adjusted R square       0.78170
                 Standard error          0.14379
```

TABLE 19

NATURAL LOG OF PROPERTY VALUES REGRESSED ON DISTANCE FROM WASTE SITE IN 1/4 MILE DUMMIES---SAMPLE 2*

```
----------------- Variables in the equation ------------------
  Variable              B              Std error B         F

  RMD         0.1011765D+00             0.24284          0.174
  AGE         0.4666507D-03             0.00169          0.076
  COND       -0.1536073D+00             0.12121          1.606
  BMT         0.4473519D-01             0.04017          1.240
  AIR        -0.1014891D+00             0.03273          9.616
  FPL        -0.7308741D-01             0.04888          2.236
  BTR         0.1157378D+00             0.05052          5.249
  OTBN        0.6445560D-01             0.04792          1.809
  DHS        -0.6360467D+00             0.23620          7.251
  SDGG        0.5387243D+00             0.10956         24.181
  SDHH        0.4911301D+00             0.10122         23.545
  SDII        0.5347432D+00             0.10776         24.625
  SDJJ        0.5560009D+00             0.11107         25.056
  SDKK        0.4457802D+00             0.10534         17.909
  SDLL        0.4508435D+00             0.10474         18.529
  SDMM        0.3692291D+00             0.10460         12.459
  SDNN        0.3804680D+00             0.11011         11.940
  SDOO        0.3007671D+00             0.10772          7.796
  SDPP        0.2909717D+00             0.10495          7.687
  SDQQ        0.3120992D+00             0.10519          8.802
  SDRR       -0.1132913D+00             0.12328          0.845
  SDSS        0.2389924D+00             0.10279          5.406
  SDTT        0.1808088D+00             0.10629          2.894
  SDUU        0.2823091D+00             0.12987          4.725
  SDVV        0.1703924D+00             0.12080          1.990
  SDWW        0.2028993D+00             0.13251          2.345
  SDXX        0.5178496D-01             0.11879          0.190
  SDYY        0.1410783D+00             0.18010          0.614
  SDZZ       -0.1123119D+00             0.18095          0.385
  SDAAA      -0.1210211D+00             0.19254          0.395
  ZNB         0.4937620D+00             0.19749          6.251
  ZNE         0.5187702D-01             0.05638          0.847
  ZNF        -0.4112283D-01             0.08694          0.224
  ZNJ        -0.4475806D+00             0.14917          9.003
  PDEN        0.5861469D-01             0.12194          0.231
  CLE        -0.7284373D+00             0.27764          6.884
  CLF        -0.4259195D+00             0.19104          4.971
  CLG        -0.1904400D+00             0.17716          1.156
  CONF       -0.3196749D-01             0.06111          0.274
  PLG        -0.8858060D-01             0.12144          0.532
  PLV        -0.3924935D-01             0.06202          0.401
  DPW        -0.3753677D-01             0.10822          0.120
  DAC         0.1177997D-01             0.02931          0.161
  LSZLN      -0.1621636D-01             0.05182          0.098
  DCBDLN     -0.3410431D-01             0.07338          0.216
  GRGB        0.1942656D+00             0.06998          7.707
```

---

* DISTANCE FROM THE CENTRAL BUSINESS DISTRICT IS ENTERED IN ITS NATURAL LOG FORM, GARAGE DUMMIED

```
GRGC         0.2264592D+00        0.07847      8.329
GRGD         0.4368506D+00        0.13964      9.787
DD4          0.1019398D-01        0.04133      0.061
DD5          0.6720049D-01        0.05080      1.750
DD6          0.2754154D+00        0.16149      2.909
DD7          0.1322364D+00        0.11057      1.430
DD8          0.1007265D+00        0.09564      1.109
DD9          0.1213786D+00        0.13148      0.852
DD10         0.1524469D+00        0.18840      0.655
HRELN        0.2283445D+00        0.08324      7.525
(Constant)   0.2027388D+01

Analysis of variance      Df   Sum of squares    Mean square      F
Regression                58.        17.06424        0.29421   13.99579
Residual                 157.         3.30036        0.02102

                   Multiple R            0.91539
                   R square              0.83794
                   Adjusted R square     0.77807
                   Standard error        0.14499
```

TABLE 20

NATURAL LOG OF PROPERTY VALUES REGRESSED ON DISTANCE FROM WASTE SITE IN 1/4 MILE DUMMIES---SAMPLE 2*

```
----------------- Variables in the equation -----------------

   Variable            B              Std error B        F

   AGE          0.5728745D-03         0.00169          0.115
   COND        -0.1761291D+00         0.11995          2.156
   BMT          0.4878491D-01         0.04050          1.451
   AIR         -0.1009231D+00         0.03262          9.572
   FPL         -0.8969001D-01         0.04928          3.312
   BTR          0.1180473D+00         0.04957          5.671
   OTBN         0.6634385D-01         0.04791          1.917
   DHS         -0.6569731D+00         0.23581          7.762
   SDGG         0.5331463D+00         0.10963         23.651
   SDHH         0.4831262D+00         0.10128         22.754
   SDII         0.5277319D+00         0.10781         23.959
   SDJJ         0.5418608D+00         0.11104         23.811
   SDKK         0.4341703D+00         0.10520         17.034
   SDLL         0.4424606D+00         0.10484         17.812
   SDMM         0.3611049D+00         0.10464         11.909
   SDNN         0.3757909D+00         0.11025         11.618
   SDOO         0.2917099D+00         0.10762          7.348
   SDPP         0.2803838D+00         0.10471          7.171
   SDQQ         0.3049756D+00         0.10521          8.402
   SDRR        -0.1207830D+00         0.12305          0.963
   SDSS         0.2322891D+00         0.10284          5.102
   SDTT         0.1758407D+00         0.10637          2.733
   SDUU         0.2745561D+00         0.13006          4.456
   SDVV         0.1669530D+00         0.12086          1.908
   SDWW         0.1905510D+00         0.13205          2.082
   SDXX         0.4767643D-01         0.11890          0.161
   SDYY         0.1252467D+00         0.18028          0.483
   SDZZ        -0.1112827D+00         0.18098          0.378
   SDAAA       -0.1306495D+00         0.19214          0.462
   ZNB          0.4242241D+00         0.14924          8.080
   ZNE          0.6022602D-01         0.05466          1.214
   ZNF         -0.4170886D-01         0.08664          0.232
   ZNJ         -0.4520360D+00         0.14920          9.180
   PDEN         0.5090824D-01         0.12189          0.174
   CLE         -0.6362223D+00         0.26973          5.564
   CLF         -0.3640266D+00         0.18634          3.816
   CLG         -0.1217255D+00         0.17234          0.499
   CONF        -0.2763600D-01         0.06102          0.205
   PLG         -0.8843124D-01         0.12155          0.529
   PLV         -0.3964814D-01         0.06208          0.408
   DPW         -0.3344016D-01         0.11276          0.088
   DAC          0.3890157D-01         0.02715          2.052
   LS7LN       -0.2459186D-01         0.05168          0.226
   DCBDLN      -0.4899219D-01         0.07233          0.459
   GRGB         0.1843292D+00         0.06776          7.399
   GRGC         0.2132630D+00         0.07441          8.214
   GRGD         0.4245215D+00         0.13921          9.299
   DD4          0.1084150D-01         0.04133          0.069
```

* REMODELLING VARIABLE OMMITTED

```
     DD5          0.6962752D-01       0.05076        1.862
     DD6          0.2765076D+00       0.16150        2.931
     DD7          0.1170097D+00       0.10981        1.135
     DD8          0.8813637D-01       0.09520        0.857
     DD9         -0.9858108D-01       0.13022        0.573
     DD10         0.1123302D+00       0.18559        0.366
     BRELA        0.2269972D+00       0.08348        7.395
     (Constant)   0.2159020D+01


Analysis of variance       Df        Sum of squares  Mean square      F
Regression                 57.            17.03703       0.29890   14.19217
Residual                  158.             3.32757       0.02106


                  Multiple R             0.91466
                  R square               0.83660
                  Adjusted R square      0.77765
                  Standard error         0.14512
```

TABLE 21

NATURAL LOG OF PROPERTY VALUES REGRESSED ON DISTANCE FROM THE WASTE SITE IN 1/4 MILE DUMMIES---SAMPLE I

```
----------------- Variables in the equation ------------------

   Variable            B               Std error B        F

   LSZLN         0.5682508D-01          0.01636        12.058
   AGE          -0.1302606D-02          0.00068         3.657
   COND         -0.1797863D+00          0.03219        31.189
   BMT          -0.4494152D-01          0.01378        10.644
   AIR          -0.4857406D-01          0.01251        15.086
   FPL          -0.5493345D-01          0.01455        14.276
   BTR           0.5217781D-01          0.01524        11.727
   HRELN         0.2977651D+00          0.03635        67.104
   GRCB          0.6897736D-01          0.02632         6.870
   GRGC          0.8162135D-01          0.02746         8.832
   GRGD          0.5351597D-01          0.06474         0.683
   OTBN          0.4973131D-01          0.02064         5.806
   DHS          -0.1984953D+00          0.08165         5.910
   DCBDLN        0.7768995D-01          0.03328         5.451
   SDTRND        0.9914428D+00          0.03645       739.524
   ZNA           0.1270313D+00          0.06086         4.356
   ZND           0.5303269D-01          0.05504         0.929
   ZNE          -0.2207217D-01          0.02240         0.971
   ZNF          -0.8056363D-01          0.02867         7.898
   ZNJ           0.4643098D-01          0.05140         0.816
   PDEN          0.1119172D+00          0.05452         4.214
   CLE          -0.3982160D+00          0.07293        29.817
   CLF          -0.2803524D+00          0.05378        27.173
   CLG          -0.5095552D-01          0.04964         1.054
   PLG           0.2120923D+00          0.08571         6.123
   PLV           0.1371651D+00          0.02658        26.624
   DPW           0.1053314D+00          0.03978         7.010
   DAC          -0.6045751D-01          0.05155         1.376
   DD11          0.2243853D+00          0.11355         3.905
   DD3           0.2384242D-01          0.02626         0.824
   DD4          -0.3041438D-01          0.02857         1.133
   DD5          -0.3012570D-01          0.03274         0.847
   DD6          -0.2082673D-01          0.05675         0.135
   DD7           0.6695275D-01          0.05553         1.454
   DD8           0.8495635D-01          0.04158         4.174
   DD9           0.1171380D+00          0.05030         5.423
   DD10          0.1748653D-01          0.05683         0.095
  (Constant)     0.1599595D+01
```

```
Analysis of variance      Df    Sum of squares Mean square      F
Regression                37.         48.15451     1.30147  103.40832
Residual                 421.          5.29861     0.01259

                 Multiple R          0.94914
                 R square            0.90087
                 Adjusted R square   0.8921[illegible]
                 Standard error      0.11[illegible]9
```

TABLE 22

NATURAL LOG OF PROPERTY VALUES REGRESSED ON THE NATURAL LOG OF DISTANCE FROM THE WASTE SITE---SAMPLE I

```
------------- Variables in the equation --------------

Variable          B              Std error B          F

LSZLN        0.7281797D-01        0.01561          21.761
AGE         -0.1835960D-02        0.00067           7.572
COND        -0.1609695D+00        0.03194          25.392
BMT         -0.3996415D-01        0.01367           8.549
AIR         -0.4751252D-01        0.01246          14.545
FPL         -0.5641131D-01        0.01464          14.855
BTR          0.6107742D-01        0.01519          16.160
HRELN        0.3032166D+00        0.03598          71.022
GRGB         0.5326246D-01        0.02626           4.113
GRGC         0.7053902D-01        0.02764           6.511
GRGD         0.4317267D-01        0.06607           0.427
OTBN         0.5156050D-01        0.02070           6.202
DHS         -0.1899253D+00        0.08096           5.503
DCBDLN       0.1327579D-02        0.02060           0.004
SDTRND       0.9959015D+00        0.03683         731.290
ZNA          0.9513569D-03        0.04737           0.000
ZNB         -0.2056105D-01        0.05114           0.162
ZNE         -0.2938117D-01        0.02013           2.131
ZNF         -0.7913083D-01        0.02690           8.651
ZNJ         -0.1648294D-01        0.04882           0.114
PDEN         0.9744135D-01        0.04949           3.877
CLE         -0.4189154D+00        0.07412          31.943
CLF         -0.2694947D+00        0.05338          25.490
CLG         -0.3501270D-01        0.04940           0.502
PLG          0.1914004D+00        0.08620           4.930
PLV          0.1237269D+00        0.02630          22.139
DPW          0.5825374D-01        0.03560           2.677
DAC          0.4353365D-01        0.03435           1.607
DWDLN       -0.8783942D-02        0.02235           0.154
(Constant)   0.1500380D+01

Analysis of variance      Df     Sum of squares   Mean square      F
Regression                29.        47.87024       1.65070    126.84300
Residual                 429.         5.58288       0.01301

            Multiple R               0.94634
            R square                 0.89556
            Adjusted R square        0.88850
            Standard error           0.11408
```

TABLE 23

NATURAL LOG OF PROPERTY VALUES REGRESSED ON THE RECIPROCAL SPECIFICATION OF DISTANCE(I/D)—SAMPLE I

```
------------------ Variables in the equation ------------------

  Variable              B            Std error B          F

  LSZLN        0.7244817D-01          0.01556         21.675
  AGE         -0.1836017D-02          0.00067          7.508
  COND        -0.1602190D+00          0.03184         25.326
  BMT         -0.4028395D-01          0.01362          8.744
  AIR         -0.4749910D-01          0.01246         14.532
  FPL         -0.5658450D-01          0.01463         14.969
  BTR          0.6127615D-01          0.01519         16.267
  HRELN        0.3027448D+00          0.03594         70.942
  GRGB         0.5369064D-01          0.02623          4.188
  GRGC         0.7110059D-01          0.02757          6.649
  GRGD         0.4559640D-01          0.06589          0.479
  OTBN         0.5207183D-01          0.02063          6.372
  DHS         -0.1876221D+00          0.08056          5.424
  DCFDLN       0.5271655D-02          0.01588          0.110
  SDTRND       0.9954872D+00          0.03681        731.338
  ZNA          0.2558153D-02          0.04724          0.003
  ZNB         -0.1779049D-01          0.05032          0.125
  ZNE         -0.3137909D-01          0.01886          2.767
  ZNF         -0.8158378D-01          0.02557         10.182
  ZNJ         -0.1734142D-01          0.04873          0.127
  PDEN         0.1002270D+00          0.04901          4.183
  CLE         -0.4180102D+00          0.07521         30.889
  CLF         -0.2690273D+00          0.05343         25.350
  CLG         -0.3468291D-01          0.04942          0.493
  PLG          0.1931039D+00          0.08600          5.042
  PLV          0.1235816D+00          0.02629         22.090
  DP4          0.5956412D-01          0.03561          2.798
  DAC          0.3908082D-01          0.03053          1.638
  DWDD         0.3666187D-02          0.01339          0.075
  (Constant)   0.1493951D+01

Analysis of variance     Df     Sum of squares   Mean square      F
Regression               29.        47.86921       1.65066   126.81579
Residual                429.         5.58391       0.01302

                Multiple R           0.94633
                R square             0.89554
                Adjusted R square    0.88847
                Standard error       0.11409
```

TABLE 24

NATURAL LOG OF PROPERTY VALUES REGRESSED ON THE LINEAR AND RECIPROCAL TRANSFORMATIONS OF DISTANCE---SAMPLE I

```
------------------ Variables in the equation ------------------

   Variable              B              Std error B          F

   LSZLN       0.7294088D-01             0.01583        21.228
   AGE        -0.1624878D-02             0.00067         7.335
   COND       -0.1607761D+00             0.03203        25.193
   BMT        -0.3998660D-01             0.01374         8.465
   AIR        -0.4760705D-01             0.01249        14.530
   FPL        -0.5633021D-01             0.01471        14.657
   BTR         0.6126777D-01             0.01521        16.226
   HRELN       0.3031807D+00             0.03607        70.647
   GRGB        0.5355846D-01             0.02628         4.155
   GRGC        0.7068736D-01             0.02771         6.509
   GRGD        0.4483450D-01             0.06611         0.460
   OTBN        0.5152366D-01             0.02089         6.085
   DHS        -0.1897802D+00             0.08159         5.410
   DCBDLN      0.1759704D-03             0.03318         0.000
   SDTRND      0.9958818D+00             0.03692       727.539
   ZNA        -0.1899682D-04             0.04953         0.000
   ZNB        -0.2052977D-01             0.05275         0.151
   ZNE        -0.2930119D-01             0.02231         1.725
   ZNF        -0.7884790D-01             0.02999         6.911
   ZNJ        -0.1726042D-01             0.04879         0.125
   PDEN        0.9609496D-01             0.05445         3.115
   CLE        -0.4171796D+00             0.07545        30.576
   CLF        -0.2689225D+00             0.05350        25.269
   CLG        -0.3482835D-01             0.04948         0.495
   PLC         0.1911940D+00             0.08679         4.853
   PLV         0.1238112D+00             0.02636        22.067
   DPW         0.5879714D-01             0.03592         2.679
   DAC         0.4501575D-01             0.04566         0.972
   DWD        -0.7893621D-02             0.04511         0.031
   DWDD        0.2073813D-03             0.02388         0.000
   (Constant)  0.1508802D+01

Analysis of variance    Df       Sum of squares   Mean square        F
Regression              30.            47.86961      1.59565     122.31358
Residual               428.             5.58352      0.01305

              Multiple R              0.94633
              R square                0.8955
              Adjusted R square       0.88822
              Standard error          0.11422
```

TABLE 25

NATURAL LOG OF PROPERTY VALUES REGRESSED ON THE 'INSIDE' AND 'OUTSIDE' CONTAMINATED ZONES COMBINED---SAMPLE I

```
----------------- Variables in the equation ------------------

        Variable            B               Std error B         F

        LSZLN       0.7507147D-01             0.01602         21.961
        AGE        -0.1783383D-02             0.00067          7.152
        COND       -0.1629842D+00             0.03212         25.755
        BMT        -0.3882015D-01             0.01379          7.921
        AIR        -0.4743901D-01             0.01248         14.446
        FPL        -0.5657620D-01             0.01467         14.882
        BTR         0.6184489D-01             0.01512         16.730
        HRELN       0.3000583D+00             0.03607         69.215
        GRGB        0.5157478D-01             0.02651          3.784
        GRGC        0.6970948D-01             0.02778          6.299
        GRGD        0.3065472D-01             0.06886          0.198
        OTBN        0.4927927D-01             0.02104          5.486
        DHS        -0.1920253D+00             0.08095          5.628
        DCBDLN     -0.6814618D-02             0.02640          0.067
        SDTRND      0.9985808D+00             0.03710        724.532
        ZNA         0.1405630D-01             0.04892          0.083
        ZNB        -0.2457540D-02             0.05489          0.002
        ZNE        -0.1850134D-01             0.02656          0.485
        ZNF        -0.6465927D-01             0.03671          3.102
        ZNJ        -0.5983187D-02             0.05144          0.013
        CZA         0.2831049D-01             0.03883          0.532
        CZB         0.6552436D-02             0.02370          0.052
        PDEN        0.9774981D-01             0.04924          3.940
        CLE        -0.4150206D+00             0.07225         32.995
        CLF        -0.2687413D+00             0.05324         25.477
        CLG        -0.3599783D-01             0.04944          0.530
        PLG         0.1874698D+00             0.08645          4.703
        PLV         0.1235145D+00             0.02632         22.015
        DPW         0.5701128D-01             0.03601          2.507
        DAC         0.4622538D-01             0.03268          2.001
        (Constant)  0.1501791D+01

Analysis of variance     Df     Sum of squares   Mean square      F
Regression               30.        47.87541        1.59585   122.45553
Residual                428.         5.57772        0.01303

                 Multiple R             0.94639
                 R square               0.89565
                 Adjusted R square      0.88834
                 Standard error         0.11416
```

TABLE 26

NATURAL LOG OF PROPERTY VALUES REGERESSED ON DISTANCE FROM THE WASTE SITE IN 1/4 MILE DUMMIES---SAMPLE 2

------------------ Variables in the equation ------------------

Variable	B	Std error B	F
LSZLN	-0.3354521D-01	0.04888	0.471
AGE	0.1029446D-02	0.00157	0.430
COND	-0.1801360D+00	0.10958	2.702
BMT	0.3322588D-01	0.03648	0.830
ATT	0.3141307D-01	0.25823	0.015
AIR	-0.8896866D-01	0.02898	9.424
FPL	-0.6392118D-01	0.04498	2.019
BTR	0.1331987D+00	0.04538	8.617
MDK	-0.4604874D-01	0.09354	0.242
HRELN	0.1931030D+00	0.07401	6.808
OTBN	0.8140826D-01	0.06956	1.370
DHS	-0.6455401D+00	0.23675	7.434
DCBDLN	-0.2911944D-01	0.06349	0.210
SDTRND	0.1014053D+01	0.07341	190.829
ZNB	0.3673595D+00	0.14731	6.219
ZNE	0.1815032D-01	0.05227	0.121
ZNF	-0.1019895D+00	0.07984	1.632
ZNJ	-0.4765513D+00	0.14975	10.123
PDEN	0.4323758D-01	0.10398	0.173
CLE	-0.6588789D+00	0.24716	7.106
CLF	-0.3739844D+00	0.17397	4.621
CLG	-0.1462648D+00	0.15963	0.840
CONF	-0.2874846D-01	0.05768	0.248
PLG	-0.9839399D-01	0.11340	0.753
PLV	-0.3274787D-01	0.05681	0.332
DPW	-0.2848936D-02	0.10052	0.001
DAC	0.1450001D-01	0.01665	0.758
GRGB	0.1659923D+00	0.06327	6.883
GRGC	0.2102363D+00	0.07120	8.718
GRGD	0.3786271D+00	0.13270	8.142
DD4	-0.2743013D-03	0.03238	0.000
DD5	0.5561135D-01	0.04634	1.440
DD6	0.3013834D+00	0.30263	0.992
DD7	0.1085973D+00	0.09825	1.222
DD8	0.5785493D-01	0.08797	0.433
DD9	0.5570605D-01	0.12059	0.213
DD10	0.8758616D-01	0.15664	0.313
(Constant)	0.2408774D+01		

Analysis of variance	Df	Sum of squares	Mean square	F
Regression	39.	16.83235	0.43160	21.50507
Residual	176.	3.53225	0.02007	

Multiple R	0.90915
R square	0.82655
Adjusted R square	0.78811
Standard error	0.14167

TABLE 27

NATURAL LOG OF PROPERTY VALUES REGRESSED ON THE CONTAMINATED ZONES AFTER INCIDENT---SAMPLES I AND 2 COMBINED

```
---------------- Variables in the equation -----------------

Variable              B             Std error B       F

LSZLN        0.6973578D-01            0.01687      17.096
AGE         -0.1472605D-02            0.00067       4.788
COND        -0.1835900D+00            0.03392      29.291
BMT         -0.2919569D-01            0.01465       3.972
AIR         -0.4657657D-01            0.01310      12.646
FPL         -0.5453523D-01            0.01598      11.654
BTR          0.6623288D-01            0.01625      16.621
HRELN        0.3089936D+00            0.03561      75.280
GRGB         0.6055403D-01            0.02731       4.917
GRGC         0.8786870D-01            0.02880       9.310
GRGD         0.9333826D-01            0.06465       2.085
OTBN         0.4813514D-01            0.02106       5.225
DHS         -0.2115232D+00            0.08399       6.342
DCBDLN      -0.2878946D-01            0.02106       1.869
SDA          0.1118305D+01            0.10703     109.170
SDB          0.1171968D+01            0.08757     179.117
SDC          0.1173413D+01            0.09210     162.335
SDD          0.1074670D+01            0.09500     127.963
SDE          0.1010272D+01            0.08860     130.020
SDF          0.1167010D+01            0.08997     168.243
SDG          0.1125449D+01            0.08916     159.351
SDH          0.1104702D+01            0.09986     122.379
SDI          0.1082230D+01            0.08844     149.733
SDJ          0.1109379D+01            0.08546     168.529
SDK          0.9578041D+00            0.08520     126.381
SDL          0.9277627D+00            0.08597     116.463
SDM          0.9113990D+00            0.08487     115.327
SDN          0.8634868D+00            0.08438     104.727
SDO          0.8352899D+00            0.08546      95.524
SDP          0.8143566D+00            0.09160      79.038
SDQ          0.8030353D+00            0.08636      86.470
SDR          0.7841710D+00            0.08383      87.505
SDS          0.7920638D+00            0.08721      82.481
SDT          0.7149520D+00            0.08834      65.500
SDU          0.7698777D+00            0.08499      82.052
SDV          0.7016588D+00            0.08500      68.148
SDW          0.6971377D+00            0.08843      62.155
SDX          0.7839902D+00            0.09157      73.309
SDY          0.6075761D+00            0.09737      38.938
SDZ          0.7804615D+00            0.09768      63.839
SDAA         0.7861508D+00            0.09287      71.664
SDBB         0.6668004D+00            0.10545      39.983
SDCC         0.7111285D+00            0.08903      63.805
SDDD         0.6195824D+00            0.09192      45.434
SDEE         0.6552238D+00            0.08610      57.907
```

```
SDFF         0.6379628D+00      0.09519        44.913
SDGG         0.6692235D+00      0.09173        53.226
SDHH         0.5930430D+00      0.08362        50.298
SDII         0.5580171D+00      0.08862        39.650
SDJJ         0.6074083D+00      0.08941        46.156
SDKK         0.5203221D+00      0.08977        33.596
SDLL         0.5314052D+00      0.08564        38.505
SDMM         0.4425589D+00      0.08606        26.445
SDNN         0.4121915D+00      0.08787        22.004
SDOO         0.3787504D+00      0.08456        20.062
SDPP         0.3662164D+00      0.08385        19.075
SDQQ         0.3743469D+00      0.08510        19.349
SDRR        -0.5702279D-01      0.10298         0.307
SDSS         0.3217187D+00      0.08520        14.258
SDTT         0.3063093D+00      0.08899        11.848
SDUU         0.3969844D+00      0.10997        13.033
SDVV         0.2729624D+00      0.10254         7.086
SDWW         0.2069348D+00      0.10542         3.853
SDXX         0.1268100D+00      0.10238         1.534
SDYY         0.1847167D+00      0.15605         1.401
SDZZ         0.1208369D-01      0.15558         0.006
SDAAA        0.5349192D-02      0.15716         0.001
ZNA         -0.1122299D-01      0.05195         0.047
ZNB          0.4116878D-01      0.05734         0.516
ZNE         -0.1416387D-02      0.02621         0.003
ZNF         -0.3393114D-01      0.03560         0.909
ZNJ         -0.5996178D-01      0.05394         1.236
PDEN         0.2801482D-01      0.04687         0.357
CLE         -0.4652950D+00      0.08066        33.273
CLF         -0.2965931D+00      0.05947        24.871
CLG         -0.1023078D+00      0.05548         3.400
CTZA         0.6521841D-01      0.03773         2.989
CTZB         0.2869877D-01      0.02207         1.691
PLG          0.8708589D-01      0.07047         1.527
PLV          0.8808066D-01      0.02736        10.362
DPW          0.3436083D-01      0.03800         0.818
DAC          0.4910573D-01      0.02999         2.681
(Constant)   0.9912837D+00



Analysis of variance       Df      Sum of squares   Mean square        F
Regression                 82.          122.33003       1.49183    84.80691
Residual                  592.           10.41381       0.01759


                 Multiple R                0.95997
                 R square                  0.92155
                 Adjusted R square         0.91068
                 Standard error            0.13263
```

LIST OF PLEASANT PLAINS VARIABLES

CODE	VARIABLE	DESCRIPTION/COMMENTS
*AIR	air conditioning	yes = 0, no = 1
AGE	age of house when sold	year built - sales date
*ATT	attic	yes = 0, no = 1
BDR	bedrooms	number of bedrooms
*BMT	basement	yes = 0, no = 1
BMTC	% finished BMT	percentage of basement finished
BTR	bathroom	# of bathrooms
COND	condition	good (G) = 1, fair (F) = 2, poor (P) = 3
*CLE	classification for below average construction	yes = 1, no = 0
*CLF	classification for average construction	yes = 1, no = 0
*CLG	classification for above average construction	yes = 1, no = 0
*CLH	classification for good grade size and construction	yes = 1, no = 0
*CLI	classificiation for high grade construction	yes = 1, no = 0
*CONB	brick construction	yes = 1, no = 0
*CONF	frame construction	yes = 1, no = 0
*CONC	concrete construction	yes = 1, no = 0

---

*Dummy variable.

CODE	VARIABLE	DESCRIPTION/COMMENTS
*CZA	contamination zone 1	yes = 1, no = 0
*CZB	contamination zone 2	yes = 1, no = 0
*CTZA	inside contamination zone 1	yes = 1, no = 0
*CTZB	inside contamination zone 2	yes = 1, no = 0
*CTZD	inside contamination zone 1 and 2 combined	yes = 0, no = 1
DAC	distance to highway access	distance measured in miles
DAR	distance to Route 9	semi dummy: first 1/4 mile = .25, second 1/4 mile = .5, > .5 = 1
*DD1 - DD10	distance from the waste dump in .25 mile dummies	DD1 = first 1/4 mile, DD2 = second 1/4 mile, etc.
DCBD	distance to central business district	distance measured in miles
DHS	distance to high school	within 1/4 mile = .25, between 1/4 and 1/2 mile = .5, over 1/2 mile = 1.
DLF	distance to landfill	within 1/4 mile = .25, between 1/4 and 1/2 mile = .5, over 1/2 mile = 1.
DNS	distance to elementary shcool	within 1/4 mile = .25, between 1/4 and 1/2 mile = .5, over 1/2 mile = 1.
DPW	distance to highway	distance measured in miles
DCBDLN	natural log of DCBD	
DWD	distance to waste dump	distance measured in miles

---

*Dummy variable.

CODE	VARIABLE	DESCRIPTION/COMMENTS
DWDD	$^{1}/$DWD	
DWDLN	natural log of DWD	
DWDSQ	DWD^{2}	
*FPL	fireplace	yes = 0, no = 1
GRG	garage	0 car = 0, 1 car = 1, 2 cars = 2, etc.
*GRGB	1 car garage	yes = 1, no = 0
*GRGC	2 car garage	yes = 1, no = 0
*GRCD	3 car garage	yes = 1, no = 0
**HARE	total floor area	measured in square feet
HRELN	natural log of total floor area	
HDEN	average number of homes per acre in enumeration district	see Table 27A on page 73
LSZ	lot size	frontage X depth, additional acres are added. Total converted to sq. ft. (1,000 ft^{2})
LSZLN	natural log of lot size	
*MDK	modern kitchen	yes = 0, no = 1
OTBF	outbuildings	total square footage
OTBN	# of outbuildings	
*PLG	inground pool	yes = 1, no pool = 0

---

*Dummy variable.
**See next section on "Further Comments" for a full description.

CODE	VARIABLE	DESCRIPTION/COMMENTS
*PLV	vinyl pool	yes = 1, no pool = 0
PDEN	average number of rooms per person in enumeration district	See Table 27A
PTO	patio, wooden deck terrace, open deck	Total square footage
PVLN	property values natural log	log of sales prices
PV	property value	sales price in $1000
RM	rooms	living/dining and kitchen/dining = 1.5
RMD	remodeled	remodeled before sale = 0, not remodeled = 1
*SDA to SDFF (1974-1981)	sales dummies	time trended according to quarter year SDA = first quarter of 1974 SDFF = last quarter of 1981
*SDGG to SDBBB (1968 to 1973)		SDGG = last quarter of 1973 SDBBB = third quarter of 1968
SDTRND	sales dummies trend for sample 1	$\sum_{i=A}^{EE} SD_i \times \text{coefficient } SD_i$
	sales dummies trend for sample 2	$\sum_{i=GG}^{AAA} SD_i \times \text{coefficient } SD_i$
UNITC	unit cost	reproduction cost, dollars per sq. ft. of ground area
*UTWC	municipal water	yes = 1, both municipal water and well water = 0

---

*Dummy variables.

CODE	VARIABLE	DESCRIPTION/COMMENTS
*UTWW	well water	yes = 1, both municipal and well water = 0
*UTSS	municipal sewerage	yes = 1, both municipal and spetic tank = 0
*UTST	septic tank	yes = 1, both municipal and septic tank = 0
*ZNA to ZNG and ZNI to ZNO	Zoning**	ZNA = Residential, Rural, yes = 1, no = 0
		ZNB = Rural Highway Business (Commercial), yes = 1, no = 0
		ZNC = Rural Highway Business (Residential), yes = 1, no = 0
		ZND = Residential, Cluster R-150, yes = 1, no = 0
		ZNE = Residential R-150, yes = 1, no = 0
		ZNF = Residential, Planned Retirement Community, yes = 1, no = 0
		ZNG = Rural Highway Business, Farm (Commercial), yes = 1, no = 0
		ZNI = Rural Highway Business, Farm (Residential) yes = 1, no = 0
		ZNJ = Residential R-400, yes = 1, no = 0
		ZNK = Highway Business, yes = 1, no = 0
		ZNL = Residential R-200, Farm, yes = 1, no = 0
		ZNM = Residential R-120, yes = 1, no = 0
		ZNN = Residential R-400, Farm, yes = 1, no = 0
		ZNO = Residential R-200, yes = 1, no = 0

---

*Dummy variables.

**See "Further Comments" for full description.

FURTHER COMMENTS ON THE VARIABLES FROM THE PLEASANT PLAINS SAMPLE

AGE - When a house is sold a few months before it is completed, the age is recorded as zero years instead of negative one year.

AIR - Air conditioning ducts were not considered as air conditioners. In a few instances, air conditioning was added between sales, and the exact date could not be determined. When this occurred, the sale was considered unusable.

BMTC - The finished portion of the basement is measured as a percentage of the groundfloor area.

BTR - The assigned value attributed to this variable is in proportion to the average assessed value for the number of fixtures in each bathroom. If an observation has more than one bathroom, the assigned values are summed. The table below describes the different values.

Assigned Value	Number of Fixtures	Description	Average Assessed Value
1.0	3	Lavatory, shower stall or shower bath	$930
0.5	2	Lavatory and sink	540
0.25	1	One of the following: Lavatory, shower stall, water closet extra, bidet	300

Source: Mr. Henbest, Deputy Tax Assessor, Dover Township, New Jersey.

CL - The class of a house is determined by the quality of its construction and its size. A large, well built house will be classed higher than a small poorly built one. There are ten house classes and they are extensively described in the New Jersey Appraisel Manual. It is important not to confuse CLASS and CONDITION. Condition is only a measure of how well a house has been kept in repair. Both high and low class houses can be in good condition.

House classes are most easily differentiated by the quality and/or quantity of the exterior walls, roof, flooring, interior walls and bathrooms. The Pleasant Plains sample is limited to single family homes of classes CLE to CLI. These classes are described below.

CLE, Below Average Grade. The exterior walls are generally frame with below average grade siding of wood, asphalt, asbestos or stucco. The roof frame is not reinforced and the shingles are of low grade. The floors are softwood or low cost hardwood with linoleum in the bathroom and kitchen. The ceiling and interior walls are painted or of papered plasterboard. There is only one three-fixture bath.

CLF, Average Grade. The exterior wall is frame with average grade siding of wood, asbestos or stucco. The roof frame is not reinforced and the shingles are of average grade. The first floor is hardwood and the upper floors are softwood. There is composition (linoleum) flooring in the kitchen and low cost tile in the bath. The interior walls are painted or papered plasterboard. There is one three-fixture bath.

CLG, Above Average Grade. The exterior and interior walls and the roof are similar to a CLF home. However, the floors are hardwood with composition flooring in the kitchen and ceramic tile in the bathroom. There is one three-fixture bath and a two-fixture toilet room.

CLH, Good Grade. The exterior wall is frame with good grade siding of wood or stucco. The roof frame is reinforced and the shingles are of heavy grade. The floors are hardwood with clear oak in principal rooms, good grade composition flooring in the kitchen and ceramic tile in the bathrooms. The interior walls are similar to a CLF home though they may have a textured finish. There is one three-fixture bathroom and a two-fixture toilet room.

CLI, High Grade. The exterior wall is equal to the quality of a class CLH home. The roof frame is reinforced and the slate or tile shingles are commercial grade. The floors are hardwood with clear oak, heavy composition flooring in the kitchen and ceramic tiles in the bathrooms. There are 2 three-fixture bathrooms and 2 two-fixture toilet rooms. The interior walls and ceilings are plastered and they are canvased and decorated.

COND - There are no set guidelines for measuring the condition of a house. Generally, as long as a house is kept repaired, it is considered in good condition. Even though this is a subjective judgment, the same four assessors have been working for the past eight years, which suggests some consistency in judgment.

If the condition variable is unmarked, then the information is taken from the three other condition variables (interior, structure and layout) and vice versa. All of these variables generally indicate the same condition.

DAC - Garden State Parkway access

DCBD - Route 9 and Mapletree St. or Freehold Rd. and Mapletree, whichever is closer.

DHS - Tom's River North High School, Indian Head and Bay Lea Rds.

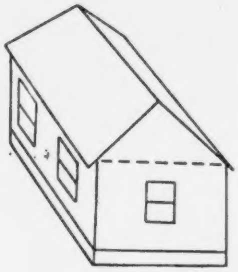
DLF - Located near Bay Rd. and Church Ave.

DNS - Located at North Dover elementary, Church Rd., and New Hampshire Ave.

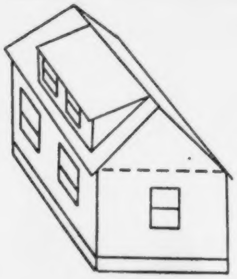
DWD - Located at Church Rd. and Route 9.

FPL - When it was not possible to determine whether the fireplace was added before or after the sale, the sale was unusable.

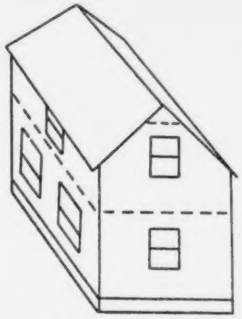
HARE - The total floor area is determined by multiplying the groundfloor area by the number of stories. Therefore, the total floor area of a two-story house is two times the groundfloor area. One and a half story (1 $1/2^{s}$.) To determine the total groundfloor area of a home, the groundfloor area was multiplied by 1.75. The useful floor area of a 1 $1/2^{s}$ home is more closely represented by multiplying the groundfloor area by 1.75 than by 1.5. See Figure below.



1 Story



1-1/2 Story



1-1/2 Story

LSZ - A lot's land size is reported on the property record cards in terms of front footage area and additional land. The two areas are combined to determine total land size. When the land size that exists at the time of a sale could not be determined, the sale was considered unusable.

MDK - This is a subjective evaluation of the kitchen and open to different interpretations. Basically, though, if the range, dishwasher and cabinets are built-in, the kitchen is modern. Non-modern kitchens are of poorer quality, the ranges and ovens are "old fashioned," the cabinets are not built-in and the sinks may be the "old board type."

If modern kitchen was not indicated on the property record card but the house was built in the 1970s, it was considered modern. (Since this variable does not have an impact on assessed value, it is sometimes ignored by the assessors.)

OTBN - An outbuilding is not attached to the main house. The quality and condition of outbuildings were not recorded because they were usually in the same condition. The class of the outbuildings was generally 4 (1 being poor and 10 being excellent), and COND was fair to poor. Garages which are also outbuildings were not included in this variable since they were already recorded.

PTO - The patio variable sums the area of all patios, wooden decks, terraces and open porches. Patios are often added between sales and therefore it is important to determine which patios existed at the time of sale. The assessed values of patios vary from $.50 to $8.00 per square foot.

RM/BDR - Rooms and bedrooms may not be reported accurately on the property record cards. The number of rooms is of minor importance to the assessment office since they do not affect the assessment value. (There is no change in assessment if a room is divided in two.)

The rooms covered by this variable are the living room, dining room, bedroom, utility room, kitchen and recreation room. If the living and dining room or kitchen and dining room are combined, they are counted as 1.5 rooms.

There was one observation with only three rooms.

Room data was not recorded on approximately 10% of the property record cards. Therefore, the average number of rooms and bedrooms were computed for both the before and after samples and then substituted for the missing data. The respective averages for the two samples are 6.5 and 3.2 for the post-1975 sales and 5.6 and 2.6 for the pre-1976 sales.

MD - This dummy variable indicates whether a house was remodeled prior to the sale. When it was impossible to determine if the remodeling took place before or after a sale, the observation was considered unusable. It is important to determine exactly when remodeling occurs, since there are sometimes more than one sale on a property record card.

SD - Sale dates were converted from years and quarters to dummy time trended variables according to the following tables:

Pre-1974

Year/Quarter	Values
1973/4 - 1973/1 =	¯3 - 0
1972/4 - 1972/1 =	¯4 - ¯7
1971/4 - 1971/1 =	¯8 - ¯11
1970/4 - 1970/1 =	¯12 - ¯15
1969/4 - 1969/1 =	¯16 - ¯19
1968/4 - 1968/1 =	¯20 - ¯23

Post-1974

Year/Quarter	Values
1974/1 - 1974/4 =	1 - 4
1975/1 - 1975/4 =	5 - 8
1976/1 - 1976/4 =	9 - 12
1977/1 - 1977/4 =	13 - 16
1978/1 - 1978/4 =	17 - 20
1979/1 - 1979/4 =	21 - 24
1980/1 - 1980/4 =	25 - 28
1981/1 - 1981/4 =	29 - 32

UTSS, UTST - When a property's water facilities are not recorded, the property is given the same facilities as its neighbors.

ZN - Residential zones are always marked with a number which pertains to minimum lot area: example R-800 = a minimum lot area of 80,000 square feet. Permitted uses for all residential zones include (1) single family dwellings; (2) non-profit private and parochial schools; (3) government buildings; and (4) essential services.

ZNA = Rural Residential

Minimum lot size: 43,560 sq. ft. (1 acre). Cluster development permitted in accordance with regulations. Permitted uses are those of all residential zone.

ZNB = Rural Highway Business Zone (RHB) (commercial).

Minimum lot size: 43,560 sq. ft. (1 acre). Permitted uses included (1) general commercial activities such as professional offices, instructional schools, eating and drinking establishments, and retail and wholesale stores. Major stipulation is that goods/raw materials cannot be processed chemically or physically, resulting in a change in the nature of the good, and (2) single-family, two-family and multi-family dwellings.

ZNC = RHB (residential).

Description same as ZNB.

ZND = Residential Zone; cluster (R-150).
R-150 zone does not distinguish between cluster and non-cluster.

Minimum lot size for cluster: 7,500 sq. ft. Permitted uses are those of all residential zones.

ZNE = Residential Zone; not cluster (R-150).

Minimum lot size: 15,000 sq. ft. Cluster development permitted in accordance with regulations. Permitted uses are those of all residential zones.

ZNF = Planned Retirement Community Zone (PRC).

Minimum lot size: 5,000 sq. ft. per unit. Permitted uses include (1) single-family dwellings (subject to provisions); (2) recreation, cultural and medical facilities, (3) essential services.

ZNG = Rural Highway Business; used, farm (RHB).
Same as ZNB in all aspects. Only difference is that the land is assessed at a lower value, which reduces property taxes.

ZNI = Rural Highway Business; unused, farm (RHB).
Same as ZNG but not used for business.

ZNJ = Residential Zone (R-400).

Minimum lot size: 43,560 sq. ft. (1 acre). Permitted uses are those of all residential zone. Cluster development permitted in accordance with regulations.

ZNK = HB Highway Business.

ZNL = Residential; farm (R-200).
Same as ZNJ, except that land is assessed as farm land.

ZNM = Residential (R-120).

Minimum lot size: 12,000 sq. ft. Permitted uses are those of residential zone. No cluster development permitted.

ZNN = Residential; farm (R-400).
Same as ZNJ except that land is assessed as farm land.

ZNO = Residential (R-200).

Minimum lot size: 20,000 sq. ft. Permitted uses are those of all residential zones (RHB). Cluster development permitted in accordance with regulations.

TABLE 27A

Enumeration District	Total Persons	Single Family Homes (1)	Mean Rooms Per Home (2)	Persons Per Unit	Rooms Per Persons	ED Land Area (Acres)	Single Family Homes Per Acre
501	247	91	5.3	2.8	1.9	674	.37
498	611	178	7.2	3.7	1.9	625	.98
409	288	100	6.7	3.5	1.9	829	.35
496	787	203	6.7	4.3	1.6	348	2.26
518	1,861	478	7.6	3.9	2.0	384	4.85
507	220	74	5.7	3.1	1.8	307	.76
505	445	131	6.9	3.4	2.0	104	4.28
508	495	273	4.5	1.9	2.4	140	3.54
509	642	290	4.9	2.3	2.1	147	4.37
500	74	24	7.2	3.5	2.1	132	0.18
Total	5,670	1,842					

Mean Rooms - Persons Per Unit: Mean calculated by taking the weighted average by single family homes.
Mean Rooms is calculated from "Year Round Housing."

(1) One unit at address

(2) Year round housing

B. Andover

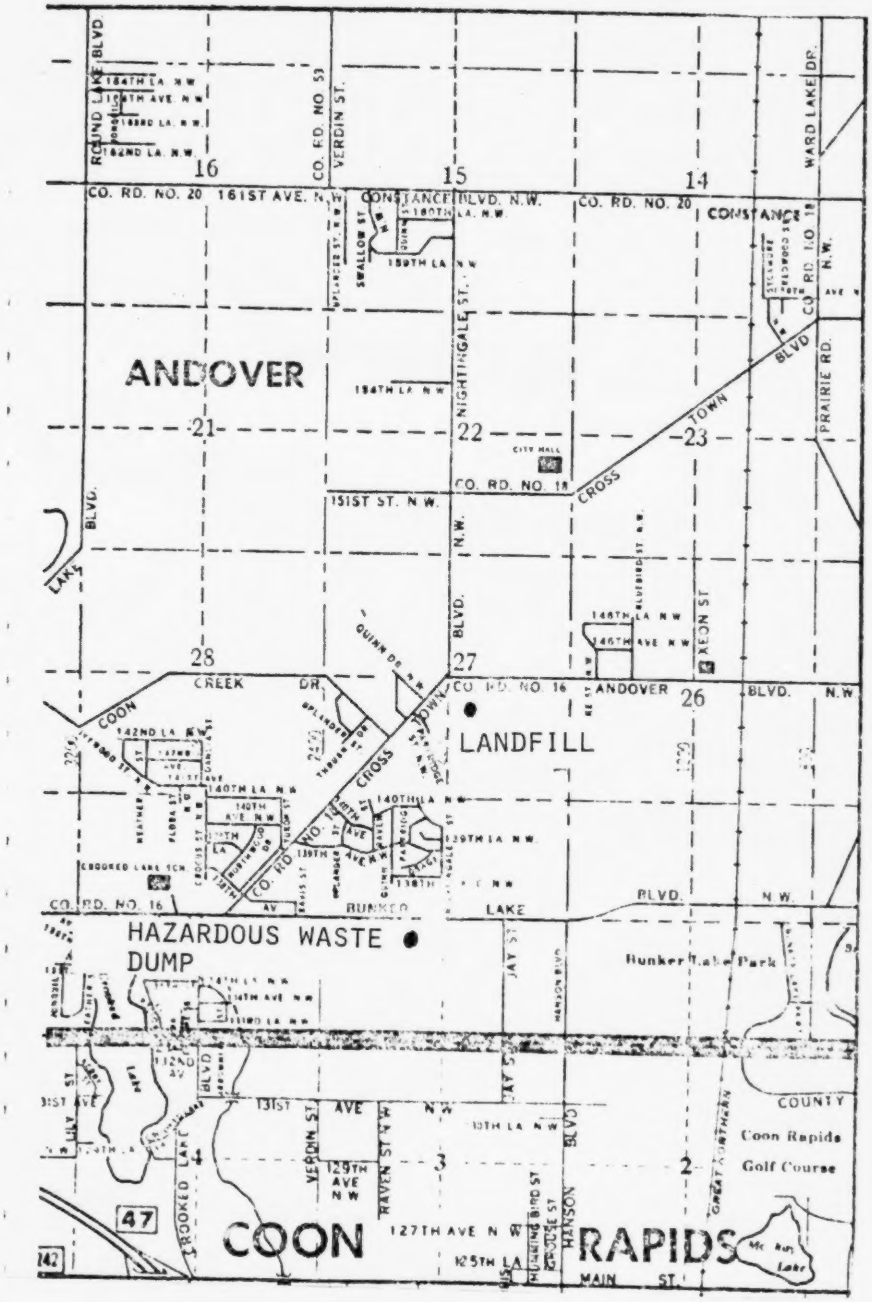
This section of Appendix C reports the results of the Andover study. Of primary concern are the five adjoining facilities just south of Bunker Lake Boulevard where, over a period of years, numerous barrels of waste solvents, paints, inks, glues and grease were dumped. The site, which from here on will be referred to as the waste dump, is located in the most southerly section of Andover approximately 20 miles north of Minneapolis. A complicating factor is the municipal landfill located south of Andover Boulevard next to Coon Creek and about a mile north of the dump. (See Map 2.)

To ascertain the economic impact of the dump, sale prices are regressed against several explanatory variables of housing characteristics in addition to distance from the dump and distance from other neighborhood amenities and disamenities. Sale prices for properties sold over a three-year period (1978-1981) and scattered within a 3.5 mile radius of the waste dump site were utilized. Data on housing sales and characteristics were obtained from the county assessor's office in Anoka, Minnesota. The overall results strongly suggest that for properties near the waste dump no decline in value occurred after groundwater contamination was discovered.

Like the Pleasant Plains case, several specifications were tried for the purpose of generating the theoretically most appropriate and significant model. In general, all the independent variables carried the correct sign except for housing unit density. However, caution must be exercised in interpreting this variable since the less densely populated homes may be located in the more rural areas where the property value is lower to

Map 2

Andover


ANDOVER
LANDFILL
HAZARDOUS WASTE DUMP
COON RAPIDS
CO. RD. NO. 20
161ST AVE. N.W.
CONSTANCE BLVD. N.W.
CO. RD. NO. 18
CROSS TOWN BLVD
NIGHTINGALE ST.
151ST ST. N.W.
CITY HALL
CO. RD. NO. 16
ANDOVER BLVD. N.W.
COON CREEK DR.
BUNKER LAKE BLVD. N.W.
CROOKED LAKE SCH.
Bunker Lake Park
Coon Rapids Golf Course
ROUND LAKE BLVD
VERDIN ST.
WARD LAKE DR.
PRAIRIE RD.
XEON ST
JAY ST
HANSON BLVD
131ST AVE N.W.
127TH AVE N.W
125TH LA
MAIN ST.
GREAT NORTHERN
COUNTY
47
242
16
15
14
21
22
23
28
27
26
4
3
2

begin with. Anyway, too much concern should not be given to this variable since it proved consistently to be insignificant. Other independent variables (especially the locational variables) tended to fluctuate in their levels of significance depending on the other variables present in the equation.

A semi-log specification was used for all but the last regression, which had a double log specification. In all cases, explanatory variables were regressed on the log of property values. The first three equations (Tables 28-30) were run stepwise. The reported results as well as any accompanying analysis for these equations are based on the steps which produced the best overall results. This was on the basis of mutually consistent criteria of a high $\overline{R}^2$ and significant F ratios.

The original variables, as indicated by Table 28, were all entered in the first regression. Although the landfill and waste dump were suspected of being highly collinear due to the close proximity of the two facilities, both were entered in the regression since this was mainly an experimental run. Similarly, BTR, BDR and RM were all entered in the first run because of its experimental nature. The omitted dummies in this case are the sale dummy representing the second quarter of 1978 (SD1), two story houses and municipal water.

The step which yielded the best results is presented in Table 28. At this point, four variables (DCL, BM, OQRS and DWD) were excluded from the equation on the basis of the minimum F criteria of the stepwise principle. It was surprising that, of the waste dump and the landfill, the latter was the stronger with a very significant F of 8.288 (the waste dump had an F of 0.0). A correlation coefficient of .82036 between the waste dump and the landfill and one of .58679 between rooms and bedrooms confirmed earlier suspicions of multicollinearity.

In order to reduce the multicollinearity, a second regression was run with DLF and BDR omitted. Removal of the landfill improved the significance of the waste dump (from 0.0 to 2.915). However, this is still below an F of 4.0 for a two-tailed test at the 95% level of confidence. The RM variable improved dramatically in its significance as a result of the omission of BDR.

From the first two regressions, a high degree of interaction was noticed among the several neighborhood variables. In addition, coefficients on the original specification of the variables representing distance from the school (DHS, DJHS, DES) proved difficult to interpret. According to the specification, similar distances for the same level school (high school, junior high, etc.), regardless of the location of the school, were given equal weight. For example, the two high schools, Blaine and Coon Rapids were represented by a single variable (DHS) in which case observations that were one half mile away from the respective schools were given the same weight, making it difficult to distinguish the effect of each school. In order to make the school variables more meaningful, amendments were made in the form of a semi-dummy applied to each school separately. For each school, a weight of .25 was given if distance from the observation was up to one-quarter mile, a weight of .5 was given for distances between one quarter and one-half mile, and 1 for distances greater than one-half mile.

As Table 30[5] indicates, the explanatory power of the neighborhood variables as well as the $\overline{R}^2$ improved dramatically with the new specification of the school variables and the exclusion of the contamination variables. Note that omission of the waste dump was not a deliberate effort but was a result of the stepwise principle. Surprisingly, the locational variables which were most highly correlated with dump were omitted from the equation along with it.

---

[5] Prior to this point, SD1 was the sales dummy being omitted, but from the first two regressions, some inconsistency between the number of stories and property values was discovered in one of the observations and the observation was deleted. Since this was the only relevant sale for that quarter, and SD2 had no observation to begin with, SD3 became the omitted dummy.

Additional changes associated with the recreational variable are reflected in the results reported in Table 30. Distance from Crooked Lake (DCL), in its original specification appeared to be capturing recreational benefits only and was respecified to capture recreational as well as aesthetic effects. The variable was transformed from a continuous variable into a dummy variable for distinguishing property value effects between homes that are within one quarter mile of the lake and those outside. Similar changes for the other recreational site (distance from Bunker Hill Park) were incorporated. (A variable is added later to capture lake view.)

Up to this point, there has been no clear evidence from the results that the presence of the waste dump triggered any substantial decline in property values. The following discussion focuses on the contamination itself as it outlines the steps that were taken to investigate the relationship, if any, between property values and the waste dump.

Tables 31-33[6] represent the efforts to isolate the relationship between property values and the dump at various distances, and to further test the hypothesized existence of a distance gradient. For this, the dump was disaggregated into one quarter mile dummies (with DWD1 representing the first one quarter mile, DWD2 representing the second quarter mile, etc.). As Figure 7 illustrates, contrary to prior hypothesis, the dummy variables were all insignificant and when plotted, failed to yield a gradient. One might argue that by a process of elimination (based on the lowest F criteria), a number of variables should have by now been omitted from the model. This might be valid; however, a deliberate effort was made to introduce the contamination dummies with as many of the original variables as possible.

---

[6] The equations with the neighborhood variables present are represented by Model A, to be distinguished from Model B which incorporates none of the neighborhood variables. Since in both instances, the proxy for the contamination variable is distance, both Model A and Model B fall within the specification of Model 1 in Chapter IV of the main body of the report.

Distance from the landfill was also disaggregated into one quarter mile dummies and entered independently of the dump into regression 32. As was the case with the dump, the landfill failed to show any system tic change in property values (Figure 8).

Table 33 reports and Figure 9 illustrates the results from combining the dummy variables of both environmental variables with the exact same variables from the two previous equations.

It may be observed from the figure that the tendency was for the dump to become stronger but generally remaining insignificant. This relationship between the waste dump and landfill was unpredicted based on the results when these variables are entered independently. However, this is just further evidence of multicollinearity which should not be totally surprising since, for the greater proportion of the sample, distance from the landfill will increase as distance from the waste dump increases.

The next three regressions (34, 35, 36) essentially reflect the effort to minimize the multicollinearity, on the one hand, between the dump and the landfill, and, on the other, between each of these environmental

DISTANCE COEFFICIENTS FROM
TABLES 31 - 33

FOR FIGURE 7

Distance (miles)	DWD Coeff.	DWD F	Obs.
0 ≥ .25	*	*	4
.25 ≥ .50	-.0270	.131	14
.50 ≥ .75	-.0297	.152	17
.75 ≥ 1.00	-.0538	.502	31
1.00 ≥ 1.25	.1056	.018	25
1.25 ≥ 1.50	-.0223	.079	28
1.50 ≥ 1.75	-.0731	.605	6
1.75 ≥ 2.00	-.0288	.104	25
2.00 ≥ 2.25	.0180	.035	22
2.25 ≥ 2.50	.1297	1.432	12
2.50 ≥ 2.75	.0195	.034	12
2.75 ≥ 3.00	-.0164	.023	20
3.00 ≥ 3.25	.0183	.028	25
3.25 ≥ 3.50	-.0057	.002	5
3.50 ≥ 3.75	**	**	0
3.75 ≥ 4.00	.0026	.000	1

FOR FIGURE 8

Distance (miles)	DLF Coeff.	DLF F	Obs.
0 ≥ .25	*	*	3
.25 ≥ .50	-.1073	2.079	8
.50 ≥ .75	-.0387	.314	15
.75 ≥ 1.00	-.0696	.827	9
1.00 ≥ 1.25	-.0708	.850	12
1.25 ≥ 1.50	.0070	.008	10
1.50 ≥ 1.75	-.0219	.082	13
1.75 ≥ 2.00	-.0315	.219	17
2.00 ≥ 2.25	.0139	.031	17
2.25 ≥ 2.50	.0370	.209	10
2.50 ≥ 2.75	-.0138	.008	1
2.75 ≥ 3.00	**	**	0
3.00 ≥ 3.25	-.0769	.191	4
3.25 ≥ 3.50	-.0030	.000	5
3.50 ≥ 3.75	-.1813	1.076	4
3.75 ≥ 4.00	-.1090	.429	7
4.00 ≥ 4.25	-.0588	.114	13
4.25 ≥ 4.50	-.1059	.344	18

FOR FIGURE 9

Distance (miles)	DWD Coeff.	DWD F	Obs.	DLF Coeff.	DLF F	Obs.
0 ≥ .25	*	*	4	*	*	3
.25 ≥ .50	-.0473	.366	14	-.0917	1.486	8
.50 ≥ .75	-.0455	.342	17	-.0063	.007	15
.75 ≥ 1.00	-.0703	.764	31	-.0265	.099	9
1.00 ≥ 1.25	-.0420	.217	25	.0122	.019	12
1.25 ≥ 1.50	-.1667	3.027	28	.1516	2.087	10
1.50 ≥ 1.75	-.2810	4.695	6	.1282	1.291	13
1.75 ≥ 2.00	-.2831	4.078	25	.1812	2.227	17
2.00 ≥ 2.25	-.2643	2.912	22	.2214	2.860	17
2.25 ≥ 2.50	-.1870	1.141	12	.2861	4.023	10
2.50 ≥ 2.75	-.3306	2.469	12	.3877	2.426	1
2.75 ≥ 3.00	-.4222	3.747	20	**	**	0
3.00 ≥ 3.25	-.4490	3.773	25	.2665	.693	4
3.25 ≥ 3.50	-.4289	2.656	5	.2503	.555	5
3.50 ≥ 3.75	**	**	0	.2130	.347	4
3.75 ≥ 4.00	-.4989	1.217	1	.3687	1.056	7
4.00 ≥ 4.25	N.A.	N.A.	N.A.	.4784	1.533	13
4.25 ≥ 4.50	N.A.	N.A.	N.A.	.4423	1.155	18

*Ommitted Dummy
**No Observations
Obs. - Number of Observations
N.A. - Not Applicable

Figure 7

Model A: Distance From Waste Dump
Along with All Neighborhood Variables (Table 31)

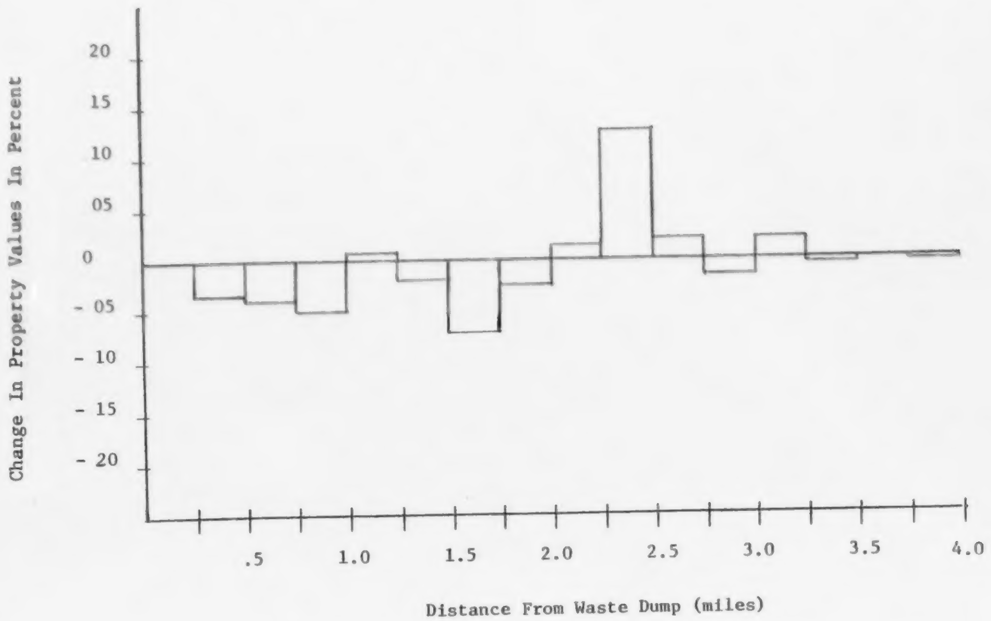


Figure 8

Model A: Distance From Landfill
Along With All Neighborhood Variables (Table 32)

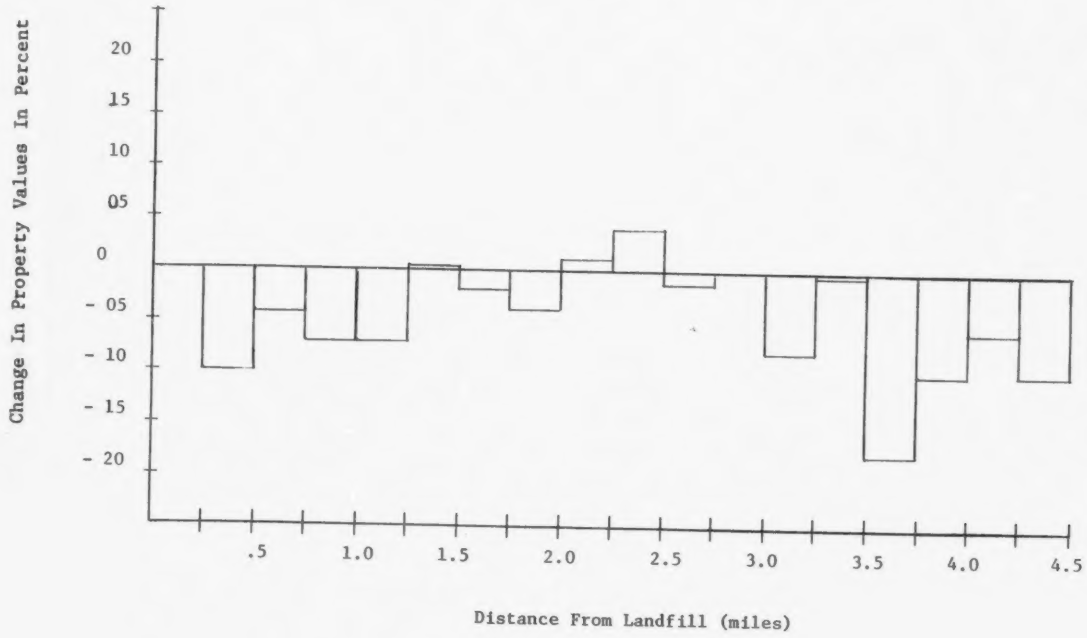
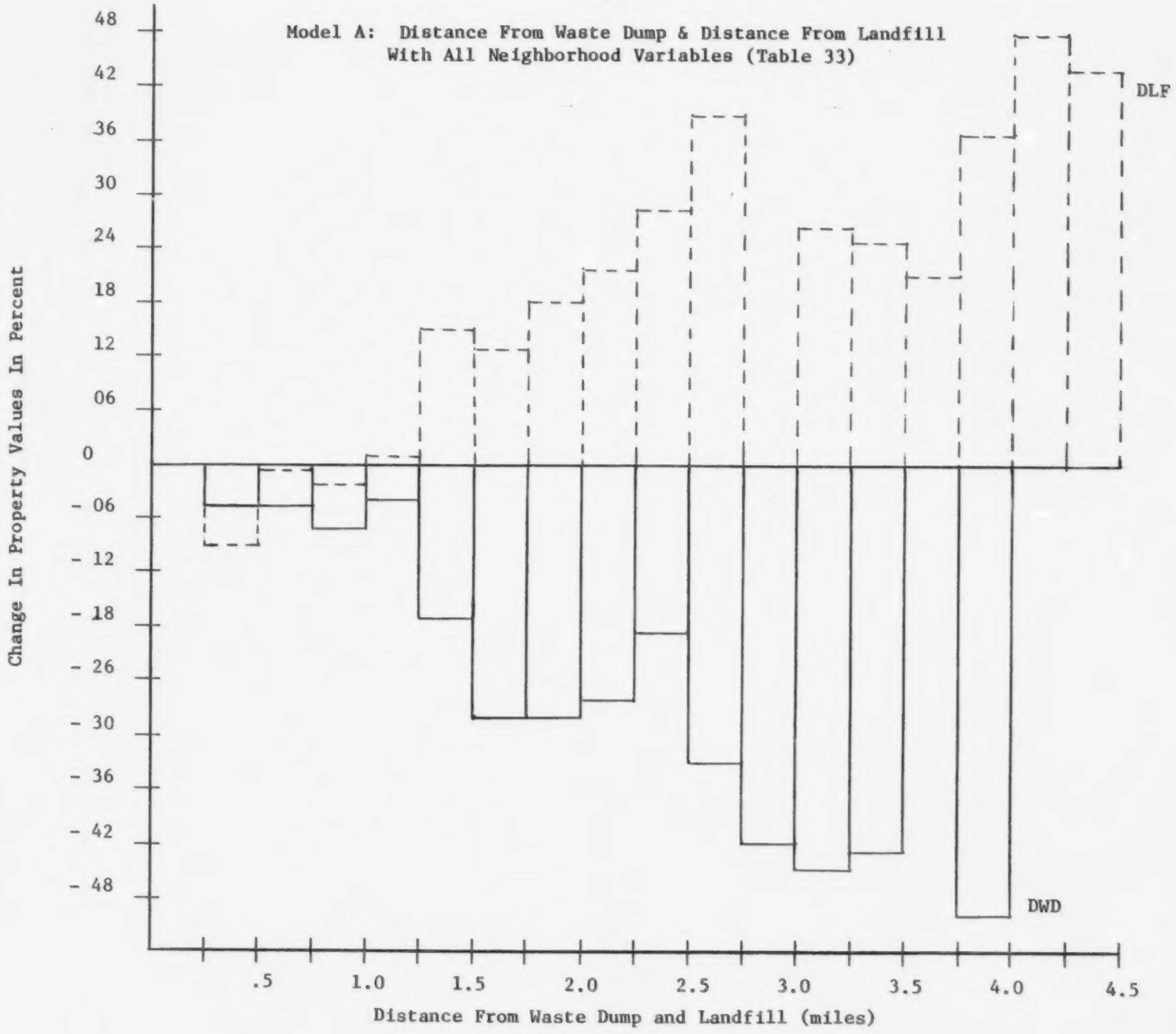


Figure 9

Model A: Distance From Waste Dump & Distance From Landfill
With All Neighborhood Variables (Table 33)



variables and the neighborhood amenities. The dump and landfill in their dummied forms were run in regressions 34 and 35, respectively, with all other neighborhood variables omitted. The other equation combined DWD and DLF with all the other variables in the above two runs. Results from these runs were compared with those in Tables 31-33.

Note that Tables 31-33 and 34-36 represent two different models.[7] The first had present all of the neighborhood variables. The second model, in contrast, omitted all the neighborhood variables. The results of the two models exhibit the same general pattern for the contamination dummies (Figures 7-9 and 10-12). The only exception was between Figures 7 and 10 where, with the omission of the locational variables, there was a much stronger (unpredicted) negative relationship between property values and the dump as distance increases. Further, when these two models are compared with the results in Table 30, it can be observed that the neighborhood variables are significant when the contamination variables are omitted, even though the reverse is not true. This is further evidence for believing that the dump fails to explain changes in property values.

At this point, it was suspected that the unexplained variation in the model was concentrated in the vicinity of the dump and was somehow responsible for its insignificance. Hence, another equation was run with all the distance variables omitted. Residuals from that regression were plotted against the observations on a detailed map of the area in an attempt to establish whether the large residuals were concentrated in the vicinity of the landfill and/or the dump. However, plotting indicated that the spectrum of (+ to -) residuals were very well dispersed. More importantly, the large residuals were not concentrated in the geographic area of either the landfill or dump.

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[7] See Footnote 6.

Later, the dump was represented as a single weighted linear term (where DWDT=1 for the first quarter mile from the waste dump and DWDT=2 for the second quarter mile, etc.). Three additional variables were also incorporated into the analysis: person density (PDEN), lake view (LKV) and distance from the Burlington Railroad tracks (DBR). At this point, the distance from the Crooked Lake variable in its various forms was omitted since it had so far proven to be insignificant. Nevertheless, *a priori* knowledge dictated that proximity to the lake should affect property values. Consequently, the variable (Lake View) was created to capture the benefits of residents who had a view of not only Crooked Lake but Round Lake also.

DISTANCE COEFFICIENT FROM
TABLES 34 - 36

FOR FIGURE 10

Distance (miles)	DWD Coeff.	DWD F	Obs.
0 ≥ .25	*	*	4
.25 ≥ .50	-.0521	.485	14
.50 ≥ .75	-.0461	.389	17
.75 ≥ 1.00	-.0542	.568	31
1.00 ≥ 1.25	-.0047	.004	25
1.25 ≥ 1.50	-.0172	.059	28
1.50 ≥ 1.75	-.0760	.790	6
1.75 ≥ 2.00	-.1075	2.150	25
2.00 ≥ 2.25	-.0853	1.353	22
2.25 ≥ 2.50	.0135	.029	12
2.50 ≥ 2.75	-.0497	.379	12
2.75 ≥ 3.00	-.0999	1.780	20
3.00 ≥ 3.25	-.0424	.319	25
3.25 ≥ 3.50	-.0466	.227	5
3.50 ≥ 3.75	**	**	0
3.75 ≥ 4.00	-.2838	3.571	1

FOR FIGURE 11

Distance (miles)	DLF Coeff.	DLF F	Obs.
0 ≥ .25	*	*	3
.25 ≥ .50	-.0615	.692	8
.50 ≥ .75	.0118	.032	15
.75 ≥ 1.00	.0011	0	9
1.00 ≥ 1.25	-.0084	.015	12
1.25 ≥ 1.50	.0654	.866	10
1.50 ≥ 1.75	.0616	.839	13
1.75 ≥ 2.00	-.0434	.465	17
2.00 ≥ 2.25	-.0287	.205	17
2.25 ≥ 2.50	.0517	.600	10
2.50 ≥ 2.75	-.0026	0	1
2.75 ≥ 3.00	**	**	0
3.00 ≥ 3.25	.0011	0	4
3.25 ≥ 3.50	.0298	.089	5
3.50 ≥ 3.75	-.0777	.557	4
3.75 ≥ 4.00	-.0128	.019	7
4.00 ≥ 4.25	.0188	.044	13
4.25 ≥ 4.50	-.0176	.029	18

FOR FIGURE 12

Distance (miles)	DWD Coeff.	DWD F	Obs.	DLF Coeff.	DLF F	Obs.
0 ≥ .25	*	*	4	*	*	3
.25 ≥ .50	-.0639	.710	14	-.0378	.270	8
.50 ≥ .75	-.0755	1.043	17	.0454	.408	15
.75 ≥ 1.00	-.0525	.484	31	.0262	.126	9
1.00 ≥ 1.25	-.0011	.000	25	.0076	.013	12
1.25 ≥ 1.50	-.0980	1.551	28	.1719	5.113	10
1.50 ≥ 1.75	-.1612	2.746	6	.0929	1.934	13
1.75 ≥ 2.00	-.1944	5.314	25	.0692	1.008	17
2.00 ≥ 2.25	-.1554	3.392	22	.0962	1.705	17
2.25 ≥ 2.50	-.0792	.664	12	.1725	5.327	10
2.50 ≥ 2.75	-.0955	1.027	12	.1390	.779	1
2.75 ≥ 3.00	-.1769	4.006	20	**	**	0
3.00 ≥ 3.25	-.1674	3.341	25	.2590	4.336	4
3.25 ≥ 3.50	-.1050	.355	5	.2717	4.173	5
3.50 ≥ 3.75	**	**	0	.1268	1.034	4
3.75 ≥ 4.00	-.5253	7.928	1	.2507	4.851	7
4.00 ≥ 4.25	N.A.	N.A.	N.A.	.2779	5.713	13
4.25 ≥ 4.50	N.A.	N.A.	N.A.	.2038	1.352	18

*Ommitted Dummy
**No Observations
Obs. - Number of Observations
N.A. - Not Applicable

Figure 10

Model B: Distance From Waste Dump
Without Neighborhood Variables (Table 34)

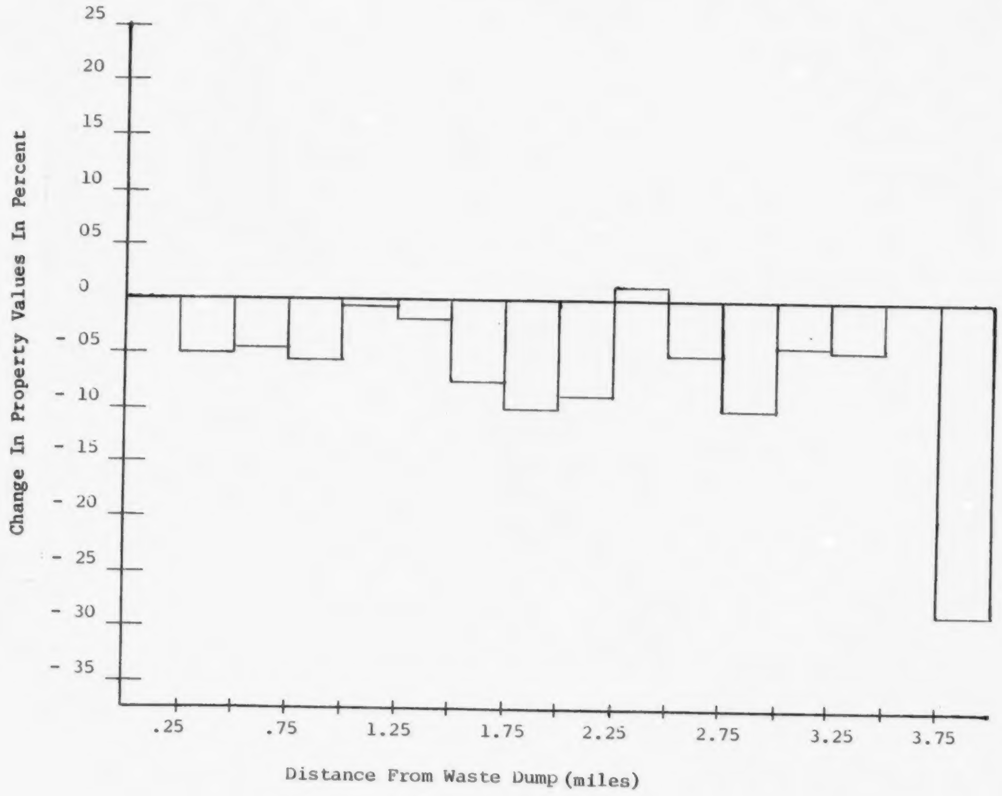


Figure 11

Model B: Distance From Landfill
Without Neighborhood Variables (Table 35)

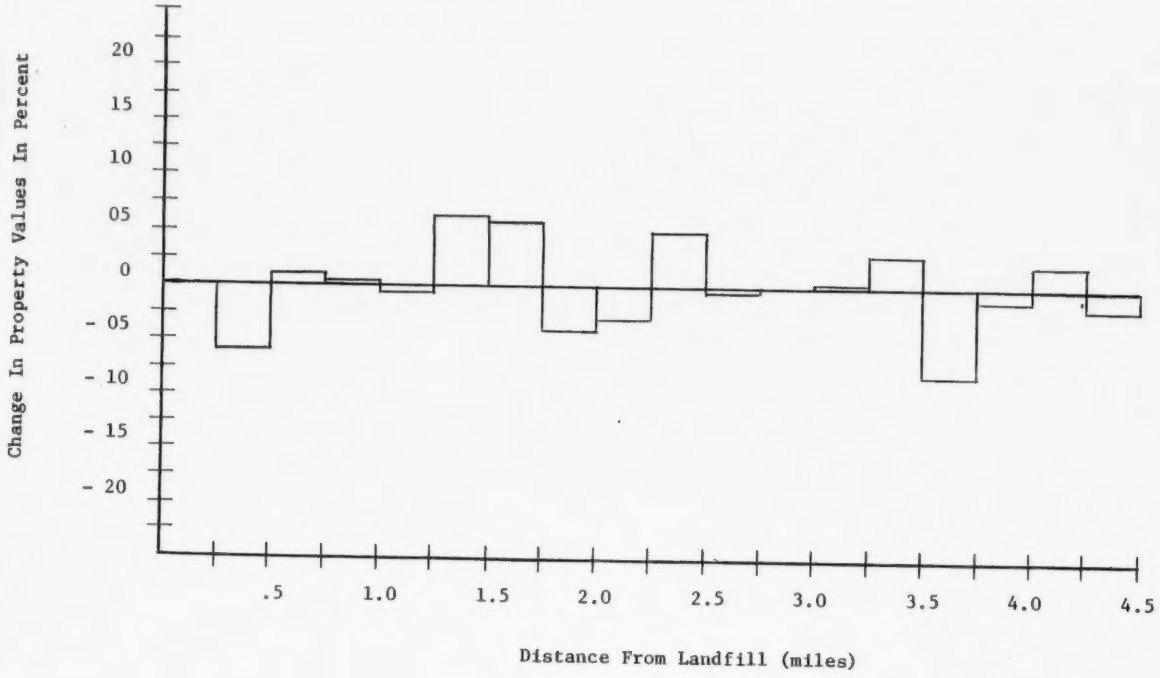
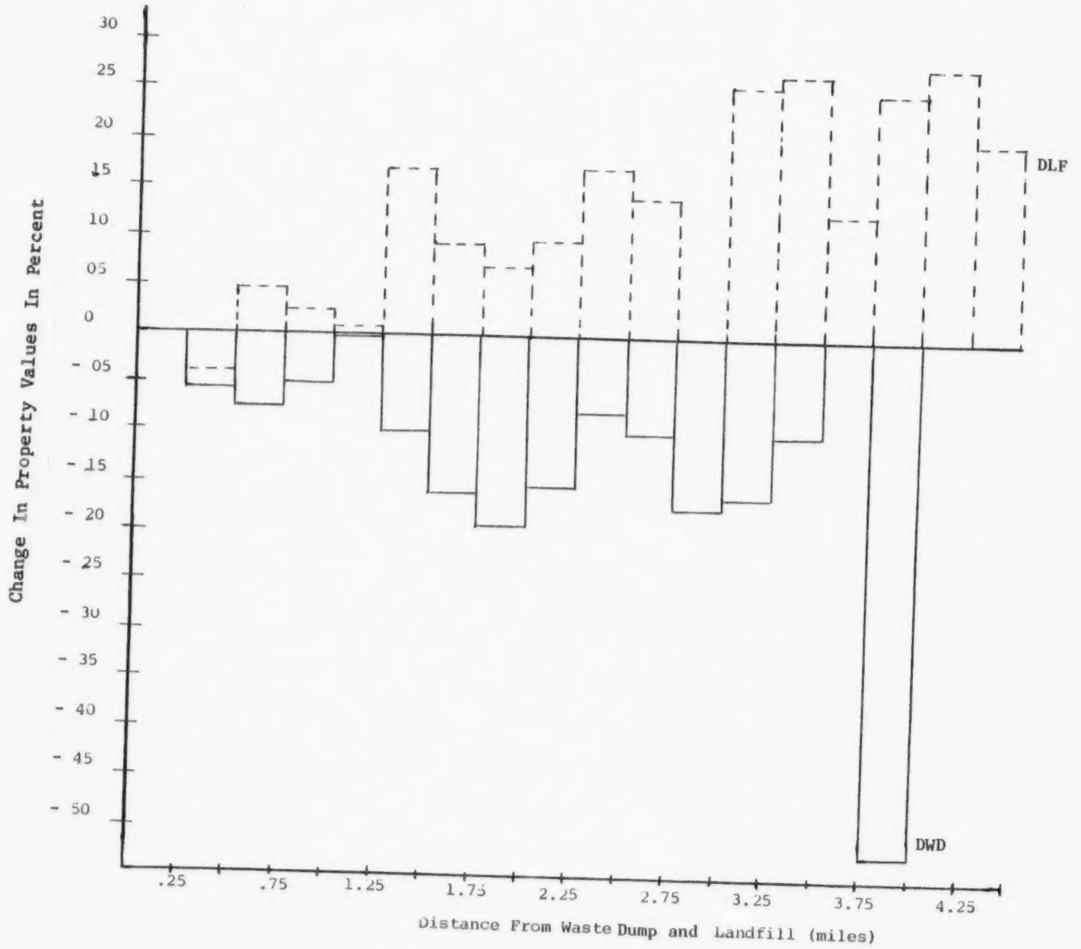


Figure 12

Model B: Distance From Waste Dump & Distance From Landfill
Without Neighborhood Variables (Table 36)



From the results in Table 37, the waste dump variable specified as a weighted linear term did not seem to offer any further explanation for variation in property values. The newly added variable, LKV, was significant, but DBR and PDEN were not.

Also reflected in Table 37 are changes in the specification of the lot size and bedroom variables. These variables are suspected of having decreasing returns to scale and were therefore entered in a log form. There is no indication that variables improved in significance as a result.

TABLE 28

NATURAL LOG OF PROPERTY VALUES REGRESSED ON DISTANCE FROM THE WASTE SITE AND DISTANCE FROM THE LANDFILL (STEPWISE)

----------------- Variables in the equation ------------------

Variable	B	Std error B	F
GFA	0.4919430D-03	0.00006	71.727
DOHS	-0.4795946D+00	0.09285	26.682
RAM	-0.1809991D+00	0.04545	15.859
BTR	0.1033363D-01	0.02852	0.131
DBH	-0.1306986D+00	0.04432	8.695
DLF	0.1107086D+00	0.03846	8.288
SD3	0.2685254D+00	0.16234	2.736
RV	0.1181595D-01	0.00926	1.628
SD4	0.4265343D+00	0.14994	8.092
SD5	0.4288497D+00	0.14870	8.317
AGE	-0.4330205D-02	0.00103	17.757
SD6	0.4318166D+00	0.15097	8.181
LSZ	0.2141311D-06	0.00000	8.384
FP	0.4469894D-01	0.02157	4.295
SD9	0.4856086D+00	0.15084	10.364
HUDENS	0.3829300D-01	0.02495	2.355
GG	0.6009458D-01	0.04618	1.693
SD7	0.5088249D+00	0.15312	11.043
SD8	0.5113413D+00	0.15449	10.955
SE	-0.1214214D+00	0.04516	7.230
SL	-0.1445396D+00	0.05509	6.884
DES	-0.2606306D-01	0.02115	1.518
DHS	0.1491883D-01	0.01880	0.630
DHWY	0.3567139D-01	0.02946	1.466
DCBD	-0.2869325D-01	0.02970	0.933
DJHS	0.2062524D-01	0.01818	1.287
BDR	0.1676191D-01	0.01631	1.056
SD15	0.5916330D+00	0.15951	13.757
SD13	0.5738921D+00	0.15295	14.078
SD10	0.5581651D+00	0.15144	13.585
WWTR	0.3088781D-01	0.04314	0.513
HDENS	0.6131426D-04	0.00009	0.422
SD14	0.5526441D+00	0.15491	12.743
SD11	0.5339109D+00	0.15053	12.581
SD12	0.5216660D+00	0.15670	11.083
(Constant)	0.2906087D+01		

```
------------- Variables not in the equation --------------


                    Variable        F

                    DCL             0.001
                    BM              0.247
                    DQRS            0.028
                    DWD             0.000
```

```
Analysis of variance     Df       Sum of squares   Mean square      F
Regression               35.             8.08063       0.23088   13.04734
Residual                214.             3.78677       0.01770


               Multiple R             0.82517
               R square               0.68091
               Adjusted R square      0.62872
               Standard error         0.13302
```

TABLE 29

NATURAL LOG OF PROPERTY VALUES REGRESSED ON DISTANCE FROM THE WASTE SITE (STEPWISE)

```
------------------ Variables in the equation ------------------
```

Variable	B	Std error B	F
GFA	0.4963107D-03	0.00006	75.901
DOHS	-0.4654162D+00	0.09243	25.353
RAM	-0.1761796D+00	0.04516	15.218
BTR	0.2335095D-02	0.02840	0.007
DBH	-0.3880805D-01	0.03229	7.563
DJHS	-0.1273585D-01	0.01021	1.556
SD3	0.2589513D+00	0.16270	2.533
LSZ	0.2032901D-06	0.00000	7.511
RM	0.1914052D-01	0.00708	7.305
AGE	-0.4488432D-02	0.00101	19.826
SD4	0.4298692D+00	0.15038	8.171
SD5	0.4369437D+00	0.14915	8.582
SD6	0.4401884D+00	0.15144	8.449
FP	0.4480111D-01	0.02130	4.424
GG	0.7421169D-01	0.04565	2.642
SD9	0.4908654D+00	0.15129	10.527
SD7	0.4969169D+00	0.15336	10.498
SD8	0.5040124D+00	0.15500	10.573
DHS	0.9778773D-02	0.01579	0.383
SE	-0.1214926D+00	0.04514	7.244
SL	-0.1373099D+00	0.05435	6.382
HUDENS	0.3694149D-01	0.02563	2.078
DWD	0.5432311D-01	0.03182	2.915
DES	-0.2686871D-01	0.01783	2.271
SD13	0.5879167D+00	0.15343	14.682
SD15	0.6004268D+00	0.15997	14.087
SD14	0.5791188D+00	0.15474	14.007
SD10	0.5612053D+00	0.15195	13.641
SD11	0.5380850D+00	0.15106	12.689
SD12	0.5258054D+00	0.15722	11.185
(Constant)	0.3093838D+01		

```
------------- Variables not in the equation --------------

                    Variable        F

                     DCL         0.430
                     DCBD        0.350
                     DHWY        0.550
                     BM          0.251
                     BDR         0.699
                     HDENS       0.676
                     WWTR        0.152
                     OQRS        0.080



Analysis of variance    Df      Mean square    Sum of squares       F
Regression              30.         0.26527           7.95812   14.86063
Residual               219.         0.01785           3.90928

                 Multiple R             0.81889
                 R square               0.67059
                 Adjusted R square      0.62546
                 Standard error         0.13361
```

TABLE 30

NATURAL LOG OF PROPERTY VALUES REGRESSED ON DISTANCE FROM THE WASTE SITE AND ALL OTHER NEIGHBORHOOD VARIABLES (STEPWISE)

----------------- Variables in the equation ------------------

Variable	B	Std error B	F
GFA	0.4541857D-03	0.00005	72.009
AGE	-0.3944935D-02	0.00114	11.878
BTR	0.2837244D-01	0.02500	1.288
DBHO	-0.1222237D+00	0.03820	10.236
OOHS	-0.7630321D+00	0.13389	32.479
RAM	-0.2972660D+00	0.05153	33.273
HUDENS	0.2638154D-01	0.02336	1.275
SE	-0.2408793D+00	0.05045	22.795
SL	-0.2455009D+00	0.05869	17.499
GG	0.8950895D-01	0.04310	4.312
SD4	0.1398419D+00	0.06222	5.052
SD6	0.1384064D+00	0.06333	4.777
SD5	0.1616718D+00	0.06185	6.833
FP	0.5502971D-01	0.02025	7.383
BDR	0.3536861D-01	0.01185	8.910
LSZ	0.2012333D-06	0.00000	7.927
SD15	0.3436920D+00	0.07927	18.798
SD13	0.3146079D+00	0.06618	22.600
SD10	0.2788232D+00	0.06545	18.146
OQRS	-0.1739249D+00	0.08827	3.883
DWAE	-0.2068042D+00	0.09435	4.804
DWE	-0.1062714D+00	0.05240	4.113
DSCE	-0.2352206D+00	0.10978	4.591
SD14	0.2774046D+00	0.06930	16.025
DCLO	0.5056958D-01	0.06174	0.671
DHWY	-0.4340500D-01	0.02066	4.412
DCRJ	-0.1467869D+00	0.05029	8.519
DCLE	-0.1299131D+00	0.05491	5.598
DCBD	0.4886642D-01	0.02112	5.353
SD11	0.2602763D+00	0.06421	16.433
SD9	0.2369805D+00	0.06281	14.236
SD8	0.2453041D+00	0.06682	13.477
SD12	0.2530747D+00	0.07537	11.274
SD7	0.2095575D+00	0.06916	9.181
DMBE	-0.4321854D-01	0.03801	1.293
(Constant)	0.3555547D+01		

```
------------- Variables not in the equation --------------


                 Variable      F

                 BM           0.626
                 HDENS        0.037
                 MWTR         0.543
                 DCRS         0.466
                 DBS          0.901
                 DFMJ         0.150
                 DRJ          0.009
                 DHE          0.388
                 DWD          0.379



Analysis of variance       Df      Sum of squares Mean square      F
Regression                 35.            7.91909     0.22626   15.29811
Residual                  211.            3.12070     0.01479


                    Multiple R          0.84695
                    R square            0.71732
                    Adjusted R square   0.67043
                    Standard error      0.12161
```

TABLE 31

NATURAL LOG OF PROPERTY VALUES REGRESSED ON DISTANCE FROM THE WASTE SITE IN 1/4 MILE DUMMIES WITH ALL OTHER NEIGHBORHOOD VARIABLES

----------------- Variables in the equation -----------------

Variable	B	Std error B	F
DCBD	0.4817485D-01	0.03350	2.068
DHWY	-0.6936202D-01	0.03882	3.193
GG	0.9451175D-01	0.04655	4.122
AGE	-0.4581957D-02	0.00134	11.718
BM	0.5732684D-01	0.05023	1.303
BTR	0.5297725D-01	0.02683	3.899
HDENS	0.8088023D-04	0.00011	0.524
FP	0.5374915D-01	0.02229	5.813
GFA	0.4360429D-03	0.00006	48.354
MWTR	0.7297114D-02	0.08617	0.007
OQRS	-0.1486004D+00	0.09689	2.352
RAM	-0.2989567D+00	0.06017	24.688
SE	-0.2697599D+00	0.05702	22.379
SL	-0.2700317D+00	0.06604	16.721
OOHS	-0.6546526D+00	0.15497	17.847
HUDENS	0.1367193D-01	0.02810	0.237
DCRS	0.9993454D+00	428304.52400	0.000
DBS	0.9853598D+00	428304.52400	0.000
DFMJ	-0.5558517D+00	428304.52400	0.000
DRJ	-0.5354847D+00	428304.52400	0.000
DCRJ	-0.8728115D+00	428304.52400	0.000
DWAE	-0.1620421D+00	0.12749	1.615
DCLE	-0.8184060D-01	0.07414	1.219
DMBE	0.1713945D+00	0.15405	1.238
DSCE	-0.3240996D+00	0.12917	6.295
DHE	0.8269294D-01	0.09350	0.782
DWE	-0.9264154D-01	0.07583	1.492
DBHO	-0.1073988D+00	0.04993	4.627
DCLQ	-0.1537154D+00	0.08394	3.354
SD4	0.1244559D+00	0.06696	3.455
SD5	0.1512560D+00	0.06635	5.196
SD6	0.1290777D+00	0.06836	3.564
SD7	0.1646006D+00	0.07374	4.983
SD8	0.2183175D+00	0.07218	9.148
SD9	0.2297143D+00	0.06823	11.336
SD10	0.2623921D+00	0.07123	13.569
SD11	0.2522344D+00	0.07009	12.950
SD12	0.2233840D+00	0.08081	7.641
SD13	0.3027145D+00	0.07116	18.097
SD14	0.2696677D+00	0.07481	12.993
SD15	0.3124452D+00	0.08593	13.221
DWD2	-0.2705573D-01	0.07469	0.131
DWD3	-0.2972859D-01	0.07617	0.152
DWD4	-0.5375499D-01	0.07588	0.502
DWD5	0.1056035D-01	0.07968	0.018
DWD6	-0.2226304D-01	0.07913	0.079
DWD7	-0.7307103D-01	0.09391	0.605
DWD8	-0.2884111D-01	0.08935	0.104
DWD9	0.1806358D-01	0.09676	0.035
DWD10	0.1297378D+00	0.10843	1.432

```
DWD11          0.1951112D-01          0.10594        0.034
DWD12         -0.1636382D-01          0.10688        0.023
DWD13          0.1828171D-01          0.11009        0.028
DWD14         -0.5728796D-02          0.11995        0.002
DWD16          0.2549264D-02          0.20394        0.000
LSZ            0.2025970D-06          0.00000        6.814
(Constant)     0.3314302D+01
```

```
Analysis of variance    Df     Sum of squares   Mean square     F
Regression              56.          8.00974       0.14303   8.96878
Residual               190.          3.03006       0.01595
```

```
Multiple R                 0.85178
R square                   0.72553
Adjusted R square          0.64464
Standard error             0.12628
```

TABLE 32

NATURAL LOG OF PROPERTY VALUES REGRESSED ON DISTANCE FROM THE LANDFILL IN 1/4 MILE DUMMIES WITH ALL OTHER NEIGHBORHOOD VARIABLES

----------------- Variables in the equation ----------------

Variable	B	Std error B	F
DCBD	0.4114060D-01	0.03463	1.411
DHWY	-0.4937154D-01	0.03402	2.106
GG	0.1055949D+00	0.04586	5.302
AGE	-0.3421485D-02	0.00128	7.119
BM	0.4196721D-01	0.04847	0.750
BTR	0.4037233D-01	0.02666	2.293
HDENS	0.1042887D-03	0.00014	0.534
FP	0.4786042D-01	0.02207	4.702
GFA	0.4686497D-03	0.00006	57.384
MWTR	0.4268778D-01	0.09032	0.223
DQRS	-0.1788227D+00	0.09624	3.452
RAM	-0.3345835D+00	0.05798	33.303
SE	-0.2910155D+00	0.05669	26.355
SL	-0.3034727D+00	0.06541	21.528
OOHS	-0.7556547D+00	0.15221	24.648
HUDENS	0.3754328D-01	0.02810	1.785
DCRS	0.8203560D+00	428207.48500	0.000
DBS	0.7698103D+00	428207.48500	0.000
DFMJ	-0.6042833D+00	428207.48500	0.000
DRJ	-0.6261661D+00	428207.48500	0.000
DCRJ	-0.8645991D+00	428207.48500	0.000
DWAE	-0.2127685D+00	0.12369	2.959
DCLE	-0.8551186D-01	0.08500	1.012
DMBE	0.5951597D-01	0.17707	0.113
DSCE	-0.2090853D+00	0.13319	2.464
DHE	0.3564080D-01	0.11825	0.091
DWE	-0.1196332D+00	0.07574	2.495
DBHD	-0.1016063D+00	0.05031	4.078
DCLQ	-0.9719980D-01	0.08227	1.396
SD4	0.1020746D+00	0.06879	2.202
SD5	0.1366114D+00	0.06723	4.129
SD6	0.9987960D-01	0.06864	2.117
SD7	0.1509925D+00	0.07591	3.956
SD8	0.2000311D+00	0.07277	7.556
SD9	0.2041143D+00	0.06859	8.855
SD10	0.2503577D+00	0.07300	11.762
SD11	0.2313946D+00	0.07197	10.338
SD12	0.2216681D+00	0.08139	7.417
SD13	0.2804611D+00	0.07239	15.012
SD14	0.2402207D+00	0.07634	9.901
SD15	0.3034477D+00	0.08710	12.139
DLF2	-0.1072925D+00	0.07441	2.079
DLF3	-0.3871582D-01	0.06906	0.314
DLF4	-0.6964652D-01	0.07658	0.827
DLF5	-0.7084576D-01	0.07685	0.850
DLF6	0.7035949D-02	0.08010	0.008
DLF7	-0.2193941D-01	0.07646	0.082
DLF8	-0.3414822D-01	0.07301	0.219

```
DLF9           0.1391121D-01           0.07847         0.031
DLF10          0.3699374D-01           0.08094         0.209
DLF11         -0.1385931D-01           0.15571         0.008
DLF13         -0.7690193D-01           0.17599         0.191
DLF14         -0.2999863D-02           0.16377         0.000
DLF15         -0.1812982D+00           0.17479         1.076
DLF16         -0.1089827D+00           0.16649         0.429
DLF17         -0.5877593D-01           0.17409         0.114
DLF18         -0.1059473D+00           0.18053         0.344
LS2            0.2340100D-06           0.00000         8.763
(Constant)     0.3488990D+01
```

```
Analysis of variance    Df    Sum of squares  Mean square    F
Regression              58.        8.04299      0.13867  8.69940
Residual               188.        2.99680      0.01594

                  Multiple R            0.85355
                  R square              0.72855
                  Adjusted R square     0.64480
                  Standard error        0.12626
```

TABLE 33

NATURAL LOG OF PROPERTY VALUES REGRESSED ON DISTANCE FROM THE WASTE SITE AND DISTANCE FROM THE LANDFILL IN 1/4 MILE DUMMIES WITH ALL OTHER NEIGHBORHOOD VARIABLES

----------------- Variables in the equation ------------------

Variable	B	Std error B	F
DCBD	0.2095873D-01	0.03952	0.281
DHWY	0.3092707D-01	0.06235	0.246
GG	0.9686000D-01	0.05081	3.635
AGE	-0.4249408D-02	0.00138	9.533
BM	0.6247003D-01	0.05208	1.439
BTH	0.4437011D-01	0.02788	2.532
HDENS	0.1608115D-03	0.00015	1.148
FP	0.4493091D-01	0.02293	3.839
GFA	0.4474530D-03	0.00007	46.647
MWTR	0.1087837D+00	0.10701	1.034
DQRS	-0.1604269D+00	0.10071	2.538
RAM	-0.3204352D+00	0.06193	26.768
SE	-0.2824023D+00	0.05902	22.898
SL	-0.2972763D+00	0.06939	18.354
DUHS	-0.5659172D+00	0.17276	10.730
HUDENS	0.1916007D-01	0.03169	0.366
DCRS	0.9097274D+00	428864.61800	0.000
DRS	0.8587003D+00	428864.61800	0.000
DFMJ	-0.6159672D+00	428864.61800	0.000
DRJ	-0.6294492D+00	428864.61800	0.000
DCPJ	-0.8891040D+00	428864.61800	0.000
DWAE	-0.9906333D-01	0.15099	0.430
DCLE	-0.1347133D-01	0.10460	0.017
DMFE	0.1099515D+00	0.21299	0.266
DSCD	-0.2651917D+00	0.15974	2.756
DHE	0.6717928D-01	0.12444	0.291
DNE	-0.4564598D-01	0.11596	0.155
DBHO	-0.1105803D+00	0.05784	3.655
DCLQ	-0.2298106D+00	0.10042	5.237
SD4	0.1144298D+00	0.06996	2.676
SD5	0.1548745D+00	0.06835	5.134
SD6	0.1202324D+00	0.07022	2.931
SD7	0.1500511D+00	0.07777	3.723
SD8	0.2104782D+00	0.07443	7.997
SD9	0.2286719D+00	0.07059	10.494
SD10	0.2631180D+00	0.07448	12.480
SD11	0.2478697D+00	0.07295	11.545
SD12	0.2167019D+00	0.08326	6.774
SD13	0.2911681D+00	0.07373	15.596
SD14	0.2555175D+00	0.07908	10.441
SD15	0.3148919D+00	0.08927	12.442
DWD2	-0.4727700D-01	0.07817	0.366
DWD3	-0.4555708D-01	0.07792	0.342
DWD4	-0.7032189D-01	0.08045	0.764
DWD5	-0.4201378D-01	0.09025	0.217
DWD6	-0.1667246D+00	0.09582	3.027
DWD7	-0.2810036D+00	0.12968	4.695

```
DWD8       -0.2831009D+00       0.14020      4.078
DWD9       -0.2642890D+00       0.15488      2.912
DWD10      -0.1869571D+00       0.17505      1.141
DWD11      -0.3305772D+00       0.21039      2.469
DWD12      -0.4221649D+00       0.21910      3.747
DWD13      -0.4490298D+00       0.23118      3.773
DWD14      -0.4288842D+00       0.26316      2.656
DWD16      -0.4988831D+00       0.45223      1.217
DLF2       -0.9171001D-01       0.07523      1.486
DLF3       -0.6279894D-02       0.07718      0.007
DLF4       -0.2650452D-01       0.08437      0.099
DLF5        0.1219364D-01       0.08817      0.019
DLF6        0.1516359D+00       0.10496      2.087
DLF7        0.1282360D+00       0.11286      1.291
DLF8        0.1812233D+00       0.12144      2.227
DLF9        0.2214183D+00       0.13093      2.860
DLF10       0.2860913D+00       0.14264      4.023
DLF11       0.3877366D+00       0.24895      2.426
DLF13       0.2665176D+00       0.32016      0.693
DLF14       0.2503097D+00       0.33591      0.555
DLF15       0.2130191D+00       0.36170      0.347
DLF16       0.3686622D+00       0.35868      1.056
DLF17       0.4784583D+00       0.38647      1.533
DLF18       0.4423144D+00       0.41159      1.155
LSZ         0.2199158D-06       0.00000      7.304
(Constant)  0.3275182D+01
```

```
Analysis of variance    Df    Sum of squares  Mean square       F
Regression              72.          8.25764      0.11469     7.17284
Residual               174.          2.78215      0.01599

            Multiple R            0.86486
            R square              0.74799
            Adjusted R square     0.64371
            Standard error        0.12645
```

TABLE 34

NATURAL LOG OF PROPERTY VALUES REGRESSED ON DISTANCE FROM THE WASTE SITE IN 1/4 MILE DUMMIES WITHOUT NEIGHBORHOOD VARIABLES

```
----------------- Variables in the equation ------------------

Variable              B          Std error B          F

GFA          0.4391002D-03         0.00006        58.661
GG           0.8454527D-01         0.04614         3.357
BDR          0.4698166D-01         0.01293        13.209
AGE         -0.5066439D-02         0.00123        17.050
OOHS        -0.6084084D+00         0.14086        18.656
RAM         -0.2899690D+00         0.05522        27.574
SD4          0.1566066D+00         0.06474         5.851
SD5          0.1696616D+00         0.06424         6.974
SD6          0.1637115D+00         0.06646         6.069
SD7          0.2584654D+00         0.07065        13.382
SD8          0.2425162D+00         0.07015        11.952
SD9          0.2670166D+00         0.06562        16.557
SD10         0.2992539D+00         0.06729        19.779
SD11         0.2665219D+00         0.06657        16.027
SD12         0.2618918D+00         0.07732        11.472
SD13         0.3123330D+00         0.06805        21.068
SD14         0.3079524D+00         0.07213        18.227
SD15         0.3534434D+00         0.08379        17.793
SE          -0.2505176D+00         0.05444        21.174
SL          -0.2398281D+00         0.06269        14.635
FP           0.6887390D-01         0.02090        10.861
WWTR        -0.1013092D-02         0.02928         0.001
OQRS        -0.1543839D+00         0.08995         2.946
BM           0.4773903D-01         0.04915         0.943
DWD2        -0.5213344D-01         0.07487         0.485
DWD3        -0.4610535D-01         0.07397         0.389
DWD4        -0.5419382D-01         0.07189         0.568
DWD5        -0.4681651D-02         0.07308         0.004
DWD6        -0.1723180D-01         0.07117         0.059
DWD7        -0.7605670D-01         0.08555         0.790
DWD8        -0.1074871D+00         0.07331         2.150
DWD9        -0.8533634D-01         0.07338         1.353
DWD10        0.1346966D-01         0.07917         0.029
DWD11       -0.4967717D-01         0.08064         0.379
DWD12       -0.9989922D-01         0.07488         1.780
DWD13       -0.4235000D-01         0.07500         0.319
DWD14       -0.4664918D-01         0.09801         0.227
DWD16       -0.2838196D+00         0.15018         3.571
LSZ          0.2811696D-06         0.00000        15.038
(Constant)   0.3469368D+01

Analysis of variance      Df       Sum of squares  Mean square       F
Regression                39.             7.67076      0.19669   12.08481
Residual                 207.             3.36903      0.01628

                 Multiple R             0.83356
                 R square               0.69483
                 Adjusted R square      0.63733
                 Standard error         0.12758
```

TABLE 35
NATURAL LOG OF PROPERTY VALUES REGRESSED ON DISTANCE FROM THE LANDFILL IN 1/4 MILE DUMMIES WITHOUT NEIGHBORHOOD VARIABLES

------------------ Variables in the equation ------------------

Variable	B	Std error b	F
GFA	0.4456618D-03	0.00006	63.977
GG	0.8552907D-01	0.04613	3.438
BDR	0.3596513D-01	0.01258	8.175
AGE	-0.4067456D-02	0.00117	12.173
CONS	-0.7414390D+00	0.13914	28.395
RAN	-0.3193444D+00	0.05271	36.707
SD4	0.1142669D+00	0.06637	2.964
SD5	0.1402210D+00	0.06485	4.675
SD6	0.1194470D+00	0.06652	3.225
SD7	0.2071332D+00	0.07239	8.188
SD8	0.2284477D+00	0.07126	10.278
SD9	0.2241638D+00	0.06601	11.534
SD10	0.2811849D+00	0.06882	16.693
SD11	0.2259368D+00	0.06801	11.038
SD12	0.2429340D+00	0.07809	9.678
SD13	0.2916286D+00	0.06983	17.442
SD14	0.2636870D+00	0.07366	12.814
SD15	0.3334633D+00	0.08503	15.379
SE	-0.2693451D+00	0.05364	25.213
SL	-0.2553052D+00	0.06110	17.458
FP	0.6344791D-01	0.02087	9.240
WNTR	-0.6008962D-02	0.05757	0.011
DQRS	-0.1513398D+00	0.08949	2.860
BM	0.3164350D-01	0.04800	0.435
DLF2	-0.6148420D-01	0.07389	0.692
DLF3	0.1178291D-01	0.06539	0.032
DLF4	0.1114400D-02	0.07174	0.000
DLF5	-0.8372778D-02	0.06813	0.015
DLF6	0.6540295D-01	0.07027	0.866
DLF7	0.6163661D-01	0.06731	0.839
DLF8	-0.4338876D-01	0.06361	0.465
DLF9	-0.2865927D-01	0.06328	0.205
DLF10	0.5169117D-01	0.06673	0.600
DLF11	-0.2582460D-02	0.14485	0.000
DLF13	0.1102371D-02	0.10854	0.000
DLF14	0.2975689D-01	0.09990	0.089
DLF15	-0.7767803D-01	0.10404	0.557
DLF16	-0.1276689D-01	0.09317	0.019
DLF17	0.1875612D-01	0.08978	0.044
DLF18	-0.1755339D-01	0.10271	0.029
LSZ	0.2913012D-06	0.00000	17.097
(Constant)	0.3509200D+01		

```
Analysis of variance     Df      Sum of squares   Mean square       F
Regression               41.            7.71397       0.18815   11.59711
Residual                205.            3.32582       0.01622

              Multiple R            0.83591
              R square              0.69874
              Adjusted R square     0.63849
              Standard error        0.12737
```

TABLE 36

NATURAL LOG OF PROPERTY VALUES REGRESSED ON DISTANCE FROM THE WASTE SITE AND DISTANCE FROM THE LANDFILL IN 1/4 MILE DUMMIES WITHOUT NEIGHBORHOOD VARIABLES

------------------ Variables in the equation ------------------

Variable	B	Std error B	F
GFA	0.3983722D-03	0.00006	45.933
GG	0.7020928D-01	0.04910	2.045
BDR	0.4751737D-01	0.01298	13.410
AGE	-0.5134231D-02	0.00124	17.078
OOHS	-0.5278032D+00	0.15242	11.992
RAM	-0.2870276D+00	0.05546	26.789
SD4	0.1525278D+00	0.06641	5.275
SD5	0.1772476D+00	0.06463	7.521
SD6	0.1537129D+00	0.06687	5.284
SD7	0.2337929D+00	0.07331	10.171
SD8	0.2537580D+00	0.07082	12.838
SD9	0.2581647D+00	0.06679	14.940
SD10	0.2975552D+00	0.06922	18.476
SD11	0.2634514D+00	0.06819	14.926
SD12	0.2552462D+00	0.07769	10.794
SD13	0.3084809D+00	0.06934	19.794
SD14	0.3109007D+00	0.07409	17.607
SD15	0.3555597D+00	0.08516	17.441
SE	-0.2503850D+00	0.05464	20.999
SL	-0.2416091D+00	0.06266	14.866
FP	0.5194574D-01	0.02133	5.933
WWTR	0.1210418D+00	0.06488	3.480
OORS	-0.1411214D+00	0.09151	2.378
BM	0.4847052D-01	0.04891	0.982
DWD2	-0.6389563D-01	0.07583	0.710
DWD3	-0.7552462D-01	0.07396	1.043
DWD4	-0.5253306D-01	0.07551	0.484
DWD5	-0.1093444D-02	0.07929	0.000
DWD6	-0.9800747D-01	0.07870	1.551
DWD7	-0.1611544D+00	0.09726	2.746
DWD8	-0.1944276D+00	0.08434	5.314
DWD9	-0.1554509D+00	0.08441	3.392
DWD10	-0.7920302D-01	0.09721	0.664
DWD11	-0.9547520D-01	0.09421	1.027
DWD12	-0.1768711D+00	0.08837	4.006
DWD13	-0.1674157D+00	0.09159	3.341
DWD14	-0.1050024D+00	0.17628	0.355
DWD16	-0.5252871D+00	0.18656	7.928
DLF2	-0.3783917D-01	0.07288	0.270
DLF3	0.4536336D-01	0.07103	0.408
DLF4	0.2618679D-01	0.07374	0.126
DLF5	0.7584521D-02	0.06711	0.013
DLF6	0.1718816D+00	0.07601	5.113
DLF7	0.9290503D-01	0.06681	1.934
DLF8	0.6922023D-01	0.06894	1.008
DLF9	0.9616117D-01	0.07364	1.705
DLF10	0.1724891D+00	0.07474	5.327
DLF11	0.1390532D+00	0.15758	0.779

```
DLF13        0.2569730D+00
DLF14        0.2717259D+00          0.12437       4.336
DLF15        0.1268237D+00          0.13302       4.173
DLF16        0.2507368D+00          0.12474       1.034
DLF17        0.2779108D+00          0.11384       4.851
DLF18        0.2038146D+00          0.11627       5.713
LSZ          0.2921183D-06          0.17531       1.352
(Constant)   0.3381468D+01          0.00000      16.724
```

```
Analysis of variance    Df   Sum of squares   Mean square       F
Regression              55.         8.10417       0.14735   9.58693
Residual               191.         2.93562       0.01537

             Multiple R            0.85679
             R square              0.73409
             Adjusted R square     0.65752
             Standard error        0.12397
```

TABLE 37

NATURAL LOG OF PROPERTY VALUES REGRESSED ON DISTANCE FROM THE WASTE SITE TRENDED

------------------ Variables in the equation ------------------

Variable	B	Std error B	F
GFA	0.4345822D-03	0.00006	59.349
GG	0.7944043D-01	0.04347	3.339
LBDR	0.1268794D+00	0.04467	8.067
AGE	-0.4617326D-02	0.00123	14.146
OOHS	-0.7248483D+00	0.12935	31.401
RAM	-0.2971521D+00	0.05047	34.666
SD	0.2008575D-01	0.00253	63.172
SE	-0.2390002D+00	0.04995	22.899
SL	-0.2526530D+00	0.05769	19.183
FP	0.4789986D-01	0.02031	5.560
DBHO	-0.1091024D+00	0.03881	7.902
DWAE	-0.1911898D+00	0.09111	4.403
DWE	-0.1016896D+00	0.04890	4.324
DSCE	-0.2127448D+00	0.10161	4.384
OQRS	-0.2170568D+00	0.08401	6.675
BM	0.3582852D-01	0.04552	0.619
DWDT	0.1028455D-02	0.00366	0.079
PDEN	0.2589044D-01	0.02569	1.016
DBR	0.1727550D-01	0.09048	0.036
LKV	-0.9779354D-01	0.04484	4.756
DCBD	0.4394136D-01	0.02516	3.050
DHWY	-0.5997088D-01	0.02317	6.698
DCRJ	-0.1253531D+00	0.05442	5.307
DRJ	0.9013360D-02	0.04791	0.035
DCLE	-0.7842608D-01	0.05520	2.019
LLSZ	0.4084347D-01	0.01444	7.997
(Constant)	0.3651730D+01		

Analysis of variance	Df	Sum of squares	Mean square	F
Regression	26.	7.63752	0.29375	19.63635
Residual	219.	3.27614	0.01496	

Multiple R	0.83655
R square	0.69981
Adjusted R square	0.66417
Standard error	0.12231

LIST OF ANDOVER VARIABLES

CODE	VARIABLE	DESCRIPTION/COMMENTS
AGE	age of house when sold	year built - year sold
BDR	# of bedrooms	
*BM	basement	yes = 1, no = 0
BTR	# of bathrooms	
DBH	distance to recreation site - Bunker Hill	measured in miles to the closest entrance
*DBHO	observations outside 1.5 miles of Bunker Hill	yes = 1, no = 0
*DBHOH	observations within 1.5 miles of Bunker Hill	yes = 1, no = 0
DBR	distance from Burlington Railroad	distance of 50 ft. = .25, distance between 50 and 500 ft. = .5, distance greater than 500 ft. = 1
DBS	distance from Blaine Senior	distance of 1/4 mile = .25, distance between 1/4 and 1/2 mile = .5, distance greater than 1/2 mile = 1
DCBD	distance to central business district	closest CBD in miles
DCL	distance to recreation site - Crooked Lake	measured in miles to the entrance (Crooked Lake and Bunker Hill are not perfect substitutes)
DCLE	distance from Crooked Lake Elementary	distance of 1/4 mile = .25, distance between 1/4 and 1/2 mile = .5, distance greater than 1/2 mile = 1

---

*Dummy variable.

CODE	VARIABLE	DESCRIPTION/COMMENTS
*DCLQ	observations within .25 mile of Crooked Lake	yes = 1, no = 0
*DCLO	observations outside .25 mile of Crooked Lake	yes = 1, no = 0
DCRJ	distance from Coon Rapids Junior	distance of 1/4 mile = .25, distance between 1/4 and 1/2 mile = .5, distance greater than 1/2 mile = 1
DCRS	distance from Coon Rapids Senior	distance of 1/4 mile = .25, distance between 1/4 and 1/2 mile = .5, distance greater than 1/2 mile = 1
DES	distance to elementary school	elementary school that hypothetical student would attend for each given observation
DFMJ	distance from F. Moore Junior	distance of 1/4 mile = .25, distance between 1/4 and 1/2 mile = .5, distance greater than 1/2 mile = 1
DHE	distance from Hoover Elementary	distance of 1/4 mile = .25, distance between 1/4 and 1/2 mile = .5, distance greater than 1/2 mile = 1
DHS	distance to high school	high school that hypothetical student would attend for each given observation
DHWY	distance from highway	distance to closest access highway in miles
DJHS	distance from junior high school	junior high school that hypothetical student would attend for each given observation
DLF	distance from landfill	measured in miles
*DLF1 - DLF18	DLF dummies in .25 miles DLF 12 had 0 observations	yes = 1, no = 0
DMBE	distance from Morris Bye Elementary	distance of 1/4 mile = .25, distance between 1/4 and 1/2 mile = .5, distance greater than 1/2 mile = 1

---

*Dummy variable.

CODE	VARIABLE	DESCRIPTION/COMMENTS
DSCE	distance from Sand Creek Elementary	distance of 1/4 mile = .25, distance between 1/4 and 1/2 mile = .5, distance greater than 1/2 mile = 1
DRJ	distance from Roosevelt Junior	distance of 1/4 mile = .25, distance between 1/4 and 1/2 mile = .5, distance greater than 1/2 mile = 1
DWAE	distance from Washington Elementary	distance of 1/4 mile = .25, distance between 1/4 and 1/2 mile = .5, distance greater than 1/2 mile = 1
DWD	distance from waste dump	measured in miles
DWDT	distance from waste dump trend	DWDT = 1 for first 1/4 mile, DWDT = 2 for second 1/4 mile, etc.
*DWD1 - DWD16	DWD dummied in .25 mile, DWD 15 had 0 observations	yes = 1, no = 0
DWE	distance from Wilson Elementary	distance of 1/4 mile = .25, distance between 1/4 and 1/2 mile = .5, distance greater than 1/2 mile = 1
*FP	fireplace	yes = 1, no = 0
GFA	ground floor area	measured in square feet
*GG	garage	yes = 1, no = 0
HDENS	housing density	number of houses per one-half map section (one-half map section is approximately one-half square miles)
HUDENS	housing unit density	number of persons per housing unit according to census block
LBDR	natural log of bedrooms	
LKV	Lake View, (Crooked and Round Lakes)	observations right on lake = .25, 1/4 mile from lake = .5, distance greater than 1/4 mile = 1

---

*Dummy variables.

CODE	VARIABLE	DESCRIPTION/COMMENTS
LLSZ	natural log of lot size	
LPV	natural log of property values	
LSZ	lot size	square footage of land area
*MWTR	observations with municipal water	yes = 1, no = 0
*OOHS	1 and 1/2 stories (housing style)	one story with attic
OQRS	1 and 1/4 stories (housing style)	one story with crawl space
PDEN	person density	number of persons per room (HUDENS/RM)
PV	property value	net sale price of real estate measured in 000s of dollars
*RAM	rambler (housing style)	basement if present is completely underground (yes = 1, no = 0)
RM	# of rooms	
SD	sale date	time trended according to quarter year (1st quarter = 1, 2nd quarter = 2, etc.)
*SD1 - SD15	dummy variable for each quarter SD1 = second quarter of 1978	yes = 1, no = 0
SDTRND	sale date trend	$\sum_{i=4}^{15} (SD_i \times \text{coefficient of } SD_i)$
*SE	split entry (housing style)	1/2 basement underground, 1/2 basement above ground, doorway and foyer in between basement and first floor. (yes = 1, no = 0)

---

*Dummy variable.

CODE	VARIABLE	DESCRIPTION/COMMENTS
*SL	split level (housing style)	doorway is on first floor, 1/2 first floor elevated, basement is area under elevated portion of first floor only, 1/2 basement underground, 1/2 basement above ground
*TS	2 stories (housing style)	yes = 1, no = 0
*WWTR	observations with well water	yes = 1, no = 0

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*Dummy variable.

FURTHER COMMENTS ON THE VARIABLES FROM THE ANDOVER SAMPLE

BTR - Bathrooms were assessed according to the following table:

Assigned Value	Description
1	Shower-bath, lavatory and sink
3/4	Shower stall, lavatory and sink
1/2	Lavatory and sink

Source: Anoka County Assessment Office

DBH - Bunker Hill Regional Park is a 1,435 acre recreational facility which is not a perfect substitute for the Crooked Lake recreational area. Present activities are: camping, picnicking, hiking, riding, swimming, winter sports and golfing.

DCDB - Closest CBD in miles (Andover Community Shopping Center or Village Ten Shipping Center)

DCL - The recreational area adjacent to Crooked Lake offers: picnicking, boating, fishing and swimming.

DHWY - Distance to closest highway access in miles (Highway 10/47 or Route 1)

DLF - Measured in miles (The municipal landfill is located at the intersection of Crosstown Blvd. and Andover Blvd., next to Coon Creek in the city of Andover.)

DWD - Measured in miles (The waste dump is located on Musket Ranch, 2052 Bunker Lake Blvd., Andover)

LSZ - Observations located in unplatted (undeveloped) areas had the lot size in acres recorded on the sales sheet. Lot sizes for observations in platted areas had to be measured from 1/2 section maps (approximately 1/2 acre) obtained from the county surveyor's office.

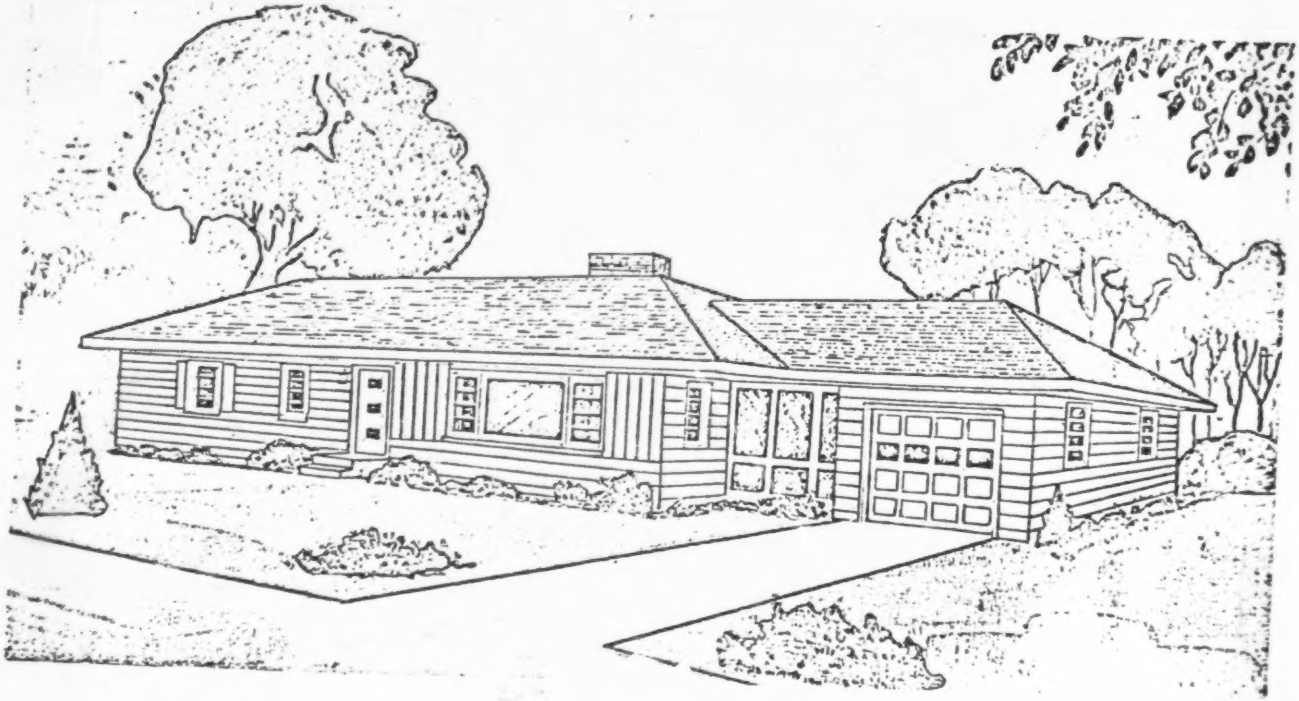
RM - Room and housing unit density data were not available for some observations. Therefore, the average number of rooms, bedrooms, bathrooms and housing unit density were computed and substituted for the missing data.

Sample Mean:	Used	Actual
Rooms	7	7.18
Bedrooms	3	3.09
Bathrooms	1	1.33
Housing Unit Density	3.7	3.7

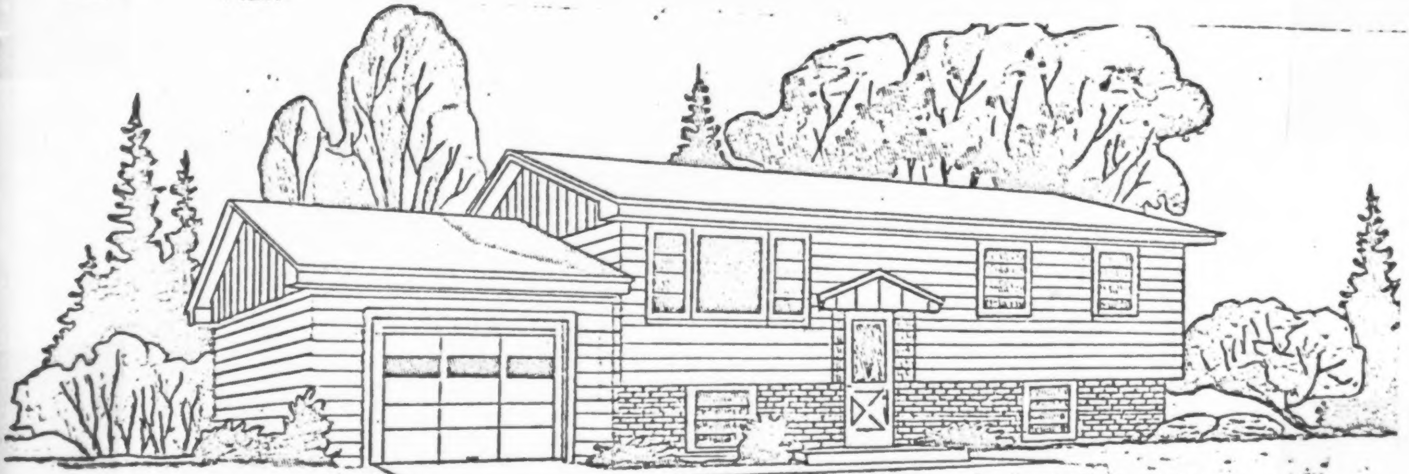
The different housing styles (two stories, one and one half stories, split entry, split level and ramblers) are illustrated below.

HOUSING STYLES

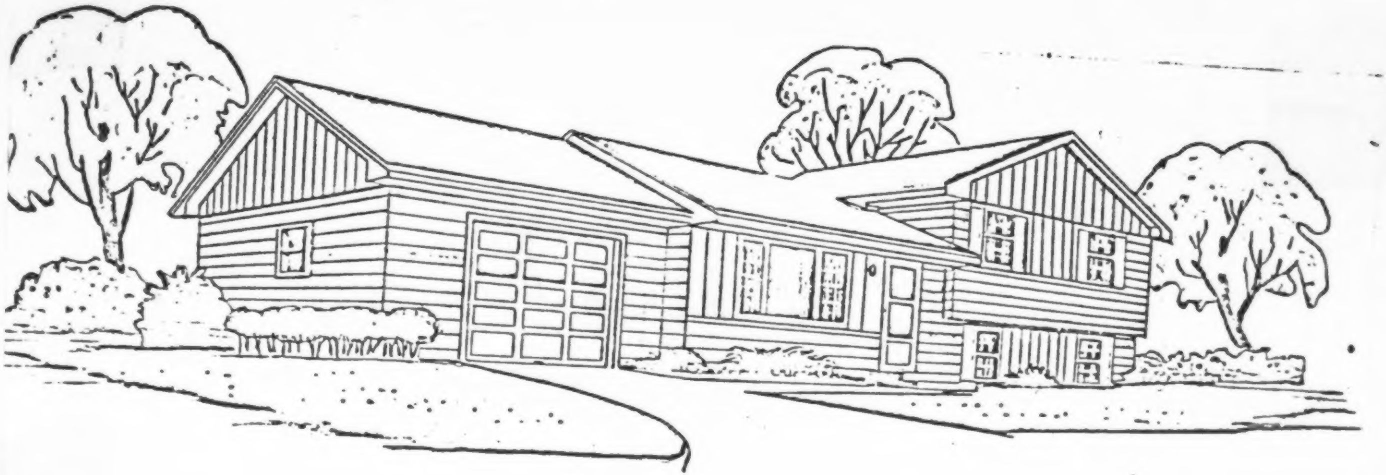
Rambler



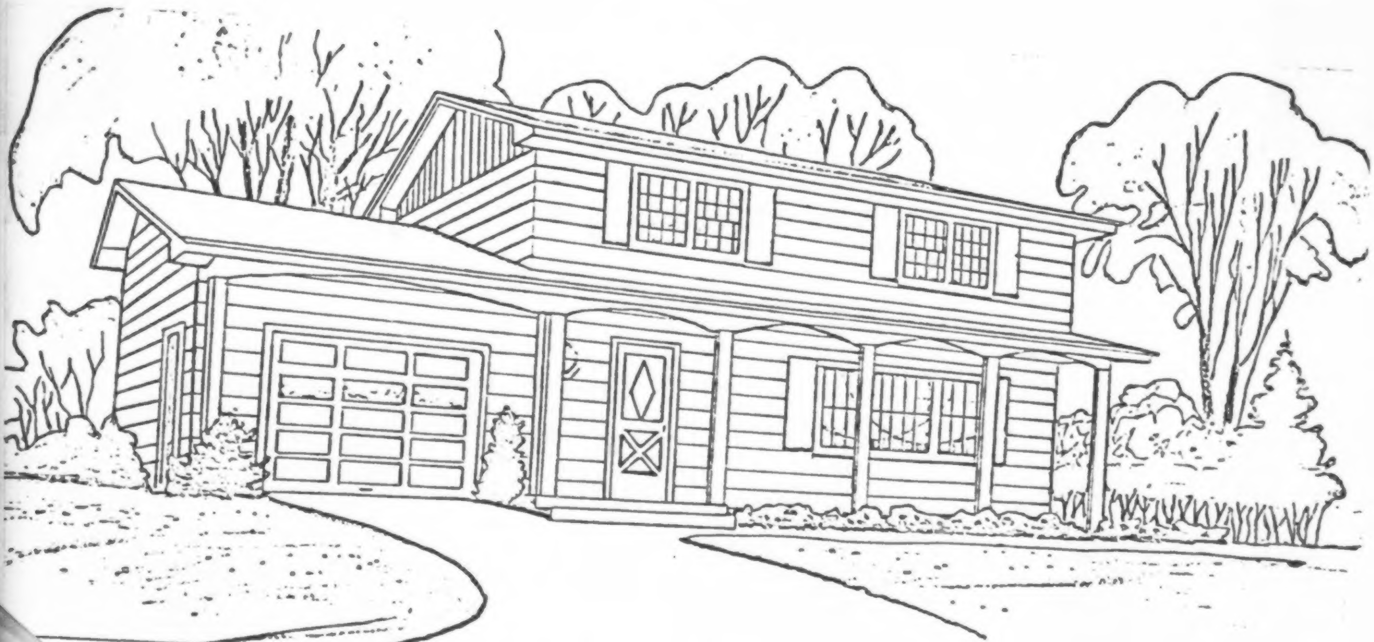
Split Entry



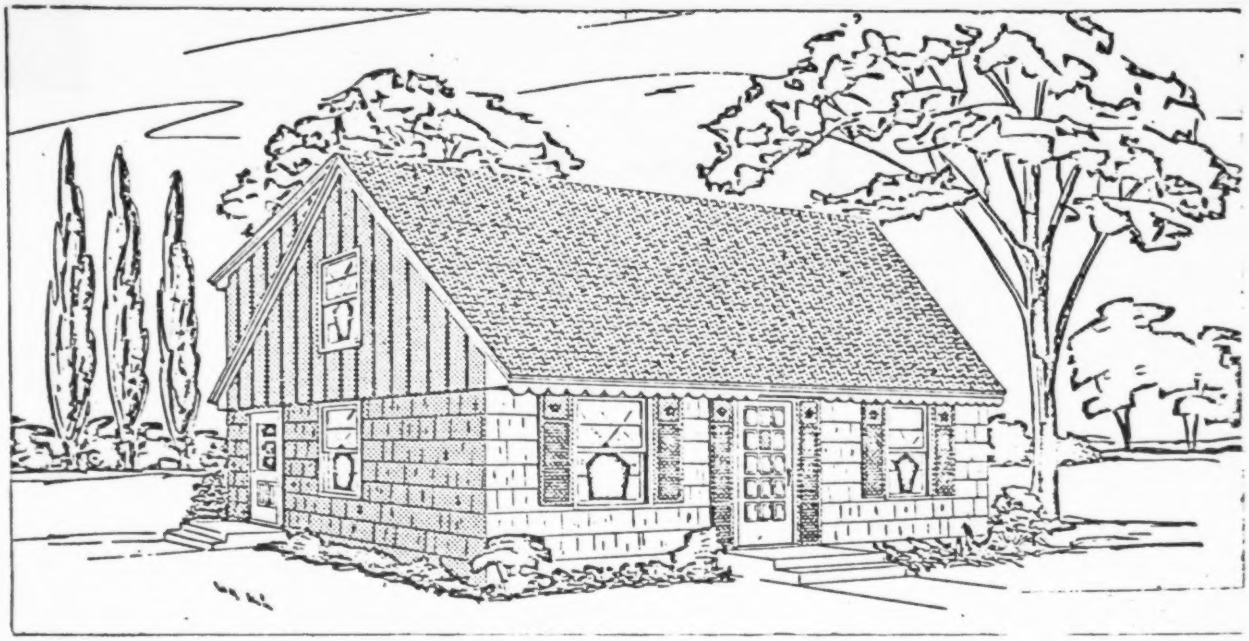
Split Level



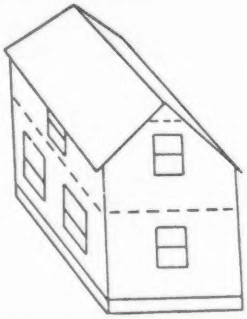
2 Stories



1 and 1/4 Stories



1 and 1/2 Stories



1-1/2 Story

Deleted Observations

Observations were deleted from both the Pleasant Plains and Andover samples for the following reasons:

1) If a lot was subdividable, generally indicated by a size of two and one half acres or greater for the Andover sample, and two acres for the Pleasant Plains sample, the observation was deleted.

Two observations with lots greater than two acres were not deleted from the Pleasant Plains sample because they were not subdividable.

2) For Pleasant Plains three lots with mansions were deleted. The special characteristics of mansions combined with their limited number was expected to bias the model.

3) Observations with homes damaged by fire were deleted. These observations were deleted because the impact that the fire had on each property's value was unknown, even after repairs.

4) All non-single family homes (e.g., apartments and commercial buildings) were deleted.

5) Whenever a transfer was: a gift, a forced sale, an inheritance, an auction sale, to or from a government or tax exempt organization, the observation was deleted. This is because price agreements in any of these instances will not adequately reflect market values.

6) Sales which occurred between relatives were also deleted. In the case of Pleasant Plains, these sales were identified by a low price, i.e., $1.00. In the face of uncertainties, transactions which occurred between individuals with the same last names were also deleted from the Pleasant Plains sample. For Andover, such sales were indicated on the record card.

7) Three observations with two dwellings on one lot were deleted from the Pleasant Plains sample because the value of the individual dwellings could not be accurately assessed.

8) Commercial properties (except for those zoned Rural Highway Business in Pleasant Plains) were deleted for a number of reasons. Residential and commercial properties cannot be included in the same sample because they each belong to distinct markets. The impact of contamination on each will, therefore, differ.

Lots zoned Rural Highway Business (RHB) were not deleted because preliminary regression analysis revealed that it was not a significant factor in determining property values. (See Section under "Further Comments on Pleasant Plains Variables," Appendix C for a description of RHB.)

9) Observations were deleted if a variable on the property record card was missing or uninterpretable.